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CONTENTS:

	PAGE
The Electric Lighting of River Steamers	253
Shipyard Lighting in Belfast (*illustrated*)	256
Curious Effects of Metallisation in a Vacuum (*illustrated*) ...	256
A Synthetic Study of Dynamo Machines (*cont.*) (*illus.*) ...	257
Continental Notes	258
American International Electrical Conference of 1892 ...	259
The New Julien Electric Car	259
Notes on the Dynamos at the Paris Exhibition—VI. (*illus.*)	260
International Congress of Electricians held at Paris, 1889 ...	262
The Maximum Efficiency of Incandescent Lamps for Central Station Work	265
Electricity as a Profession	265
The Taking over of the French Telephones by the State ...	266
Notes...	267
Dynamo Room Accessories for Intensity, Potential, and Resistance Measurements (*illustrated*)	271
The Efficiency of the Arc Lamp	273
New Patents	276
Abstracts of Published Specifications	277
On Electrolytic Polarisation by Metals...	279
Correspondence :—Electric Traction	279
Inductive Capacity of Electro-Magnets	279
Coad's Primary Battery	280
The Institution of Electrical Engineers	280

THE ELECTRIC LIGHTING OF RIVER STEAMERS.

THE advantage of lighting river steamers by electricity, in preference to the old-fashioned oil lamps, is a thing which, in this country at least, has only been recently recognised by electrical engineers, the want of attention hitherto shown having probably been due to the fact that electricians have received but little encouragement from steamship companies when overtures have been made. On some of the large American lakes and rivers, however, many of the steamers have for some time past been electrically lighted to the great satisfaction of both the passengers and crews. At the same time the cost of the installations, and their maintenance, has compared very favourably with that incurred for lighting by oil.

Turning to the European Continent, we find that on the River Seine, in France, our Gallic neighbours have taken time by the forelock, having approached the company owning the steamers plying the river for the purpose of persuading them to light their vessels by electricity. The company decided to adopt the electric light, and several of the steamers running on the Seine have for some months past been lighted electrically. Those of our readers who have visited the Paris Exhibition, and availed themselves of these vessels, must have been favourably impressed with their excellent electric lighting. They are, of course, liberally patronised, the electric illumination of itself proving no small attraction.

Coming nearer home, let us see what has been done in this direction in our own country. Occasionally it has been our lot to journey, either for business or pleasure, in the steamers plying on the Thames, and generally we have been in the evening not a little annoyed at the poor illumination of the boats. Truly there is nothing more depressing to the spirits than to journey in a boat badly lighted. The cabins and engine rooms only were lighted, whilst the decks, with the exception of the two or three lamps required to be carried according to the Thames Conservancy bye-laws remained in absolute darkness. The depression has been more marked on the homeward passage from, say, Clacton-on-Sea, Gravesend, or Hampton Court, and may be aggravated in no small degree when on a chilly evening one has to remain on deck because there is no room in the cabins. Such was the condition of affairs when the steamers now belonging to the Victoria Steamboat Association, Limited, were the property of the old company, which liquidated a year or two ago. Now, however, owing to the energetic action of the new company, four out of their large fleet of steamers have already been fitted with the electric light, these being the *Alexandra*, *Glen Rosa*, *Duke of Edinburgh*, and the *Cardinal Wolsey*. The *Alexandra*, which runs from London Bridge to Gravesend and Sheerness, was the first to be lighted electrically, and the installation was completed last year. The plant on this steamer comprises a 3 H.P. nominal Tangye steam engine, running at 230 revolutions per minute, and supplied with steam from the main boilers, and a dynamo giving 30 ampères at a pressure of 65 volts, at 650 revolutions per minute. The dynamo and steam engine are placed in a small cabin near the main engines. There are in all 30 16-C.P. lamps distributed throughout the vessel. Of these, eight are installed in the aft saloon, five under the awning, which is placed over the aft deck, four in the fore cabin, and the remainder in other parts of the vessel. The conductors are laid in such a manner that it is absolutely impossible for anyone to tamper with them. The glow lamps, which are suspended from short, plain copper fittings, are encased in globular frosted glass protectors, having copper wire guards. The five lamps placed under the awning have an exceedingly pretty effect, and effectually light the after part of the deck.

The *Glen Rosa*, which journeys between London Bridge and Clacton-on-Sea, is lighted by 19 16-C.P. lamps, seven of which are placed in the aft saloon, and four in the fore cabin, the rest being fixed in other parts of the steamer. The engine, which is of the Hindley type, is of 2 H.P. (nominal), and runs at 230 revolutions, steam being supplied, as in the previous case, from the main boilers. The dynamo, which runs at 1,500 revolutions, has an output of 30 ampères at 50 volts, and is installed, together with the steam engine, in a small engine room. The lamps in this vessel are also enclosed in lightly frosted glass protectors, having copper wire guards, and are suspended from plain copper fittings, the protectors in this case being longitudinal in shape with semi-circular bases.

In the *Cardinal Wolsey*, which plies between London Bridge and Hampton Court, there are installed 17 16-C.P. lamps in different parts of the steamer. The engine, which is again furnished with steam from the main boilers, is of the Tangye type, and of 2 H.P. (nominal), running at 250 revolutions. The dynamo runs at 1,450 revolutions, the output being 22 ampères at 50 volts pressure. On this boat the dynamo and engine are placed in the main engine room; and in this case, also, four of the lamps are placed under the awning aft on the vessel. On this steamer the fittings are nickel-plated, and the lamps have lightly frosted glass protectors and wire guards, the same as in the *Glen Rosa*, with the exception of those lights placed under the awning, which have only plain wire guards shielding the lamp.

There are fitted in the *Duke of Edinburgh*, to the electric lighting of which we referred a short time ago in connection with the recent visit of the Shah, 19 16-C.P. lamps, four of which are placed under the awning. The engine, supplied with steam from the main boilers, is of the Hindley type, of two H.P. (nominal), running at 230 revolutions. The dynamo gives 25 ampères, the E.M.F. being 50 volts. The lamps have protectors and guards similar in construction to those on board the *Glen Rosa*. The four lamps under the awning have neither protectors nor guards, but are lightly covered with coloured bell flowers, hiding the lamp fittings and causing a very pretty effect.

The foregoing description of the electric lighting of some of the Victoria Steamboat Association's boats will no doubt be read with interest by our readers, but there are one or two features in the installation to which we must still refer. In the first place, we are of opinion that the frosted glass protectors obscure the light rather more than is necessary or desirable, and on the occasion of our visit on board one of the boats the light was not quite so brilliant as we should have liked to have seen it. Probably protectors of clear glass would prove an improvement. It might be imagined that an arc light placed in the fore of a vessel would greatly conduce to the speed, by its disclosing to those on board vessels coming in an opposite direction the exact position of the steamer; experience has, however, proved that those coming in an opposite direction cannot see where they are going or what they are doing, owing to the dazzling character of the light towards which they are moving. The installations on these steamers reflect great credit on the contractors, and we are informed by them that since the fitting up of the electric light no hitch whatever has occurred. The adoption of the light by the Victoria Association on four of their steamers is very satisfactory, and we understand that they intend to introduce the system on certain of their other boats. This action will be warmly appreciated by those individuals using the steamers, and many persons who at present do not care to journey on them by night will, when the electric light is further employed, utilise such means of travelling, in this way fully recouping the association for their outlay.

A HIGHLY amusing correspondence on "Alternating Motors" is going on in the pages of a contemporary. Mr. James Swinburne is not in accord with Mr. Mordey on the question at issue, and the grave editor of the serious journal, whose columns are honoured by thus handing down to posterity a famous controversy, upholds the opinions of the latter gentleman. Mr. Swinburne, as is generally known, does not mince matters, and when anyone tries to upset a theory on the strength of experiments which really go to prove it without advancing another in its stead, he, like a good many others, endeavours to show where the fallacy lies. But the discussion partakes more of a "chaffing" match as it drags its length along, and little interpolations like the following therefore tend to enliven it. Says the sage who pilots our esteemed contemporary through the shoals which beset its course :—"Before leaving the subject, we have just one word to say upon Mr. Swinburne's controversial style. Epigrammatic and facile as it undoubtedly is, we think he would do well to sacrifice some of its superficial brilliancy in order to obviate a certain air of precocious omniscience with which his utterances are somewhat painfully pervaded. For so young a man the extent of Mr. Swinburne's practical and theoretical knowledge of physical science does him infinite credit, but he really has no sufficient title to deliver his views with all that tone of contemptuous infallibility, which, in his weaker moments, he so much affects." Mr. Swinburne, doubtless smarting under this intimation that he is too much inflated with the exuberance of his own verbosity, retaliates in the following delightfully piquant manner :—"Of course, any young fellow under fifty would forgive the bad taste of personal remarks about his extreme youth in view of the great value of fatherly advice from the venerable Nestor of Salisbury Court.

TWICE previously have the meetings of the British Association been held at Newcastle-on-Tyne, and judging by the last held in that town, that which commences on Wednesday next should prove numerically a successful one. The first held there was in the year 1838, under the presidency of the Duke of Northumberland, and the second meeting took place in 1863, with Sir William G. Armstrong as president. 3,335 attended that meeting, a number exceeded only once in the 57 years of the Association's existence, namely, on the occasion of the meeting at Manchester two years since, when Sir H. E. Roscoe, F.R.S., presided.

MANY of the Portugese towns are still lighted by oil lamps. Last year a few English engineers were moving in the matter of having them supplied with gas. If they do not hurry forward with the work they may find the lighting done by electricity.

BETTER late than never might with reason be said of the police electric pillar signals to which attention has recently been directed in the daily press by the announcement that the system has been purchased by the State. A six months' trial of 10 of these signals in Islington has proved such a complete success that a considerable extension of the system may be anticipated. We, in England, are exceedingly slow to adopt arrangements of the kind which are in very general use on the other side of the Atlantic. The use of these signals will still further add to the ever growing network of circuits which is spreading over the Metropolitan area; the fact that they are to be maintained by the State will, however, enable the wires to be carried along with those belonging to the ordinary telegraph system. It may be mentioned that the total mileage of underground wires in the metropolitan area belonging to the postal telegraph system is now close upon 15,000 miles.

It is stated that there is a possibility of the National Telephone Exchange Association of America, at a meeting which it is to hold at Minneapolis, coming out strongly in favour of some measure recommending the appointment of a State official empowered to settle differences that may arise between the local electrical companies in any town or city. Although the need of such an official in this country is probably not so great as it may be in America where the use of the telephone, alarm signals, electric light, &c., is on a much larger scale than it is here, it seems probable that at no very distant date, as progress is made, troubles may arise which could be more satisfactorily settled by a general umpire than by expensive litigation.

THE Stoke-on-Trent Town Council, who are the proprietors of the borough gas works, has decided to oppose the introduction of any bills dealing with the electric lighting of that town. The company concerned is the Midland House-to-House Electricity Company which, as far as we can learn, has not yet been floated, although it was, along with many others in the same hybrid state, registered some time ago. The Town Council in question made a net profit of 23 per cent. in the past year, and it does not intend to lose such satisfactory financial results without a struggle. Nevertheless, to show that they regard with anxiety the present development of electric lighting, we may mention that certain of the councillors have just suggested that the Corporation should make a reduction in the price of gas, presumably for the purpose of benefiting the consumers, but actually through the fear of the competition of the electric lighting companies. Why should not the council itself take up the supply of electricity and thereby further increase their revenue? This would of course find some work for electrical engineers.

THE directors of the Partick, Hillhead and Maryhill Gas Company state that they do not fear any serious competition from the electric lighting companies, but that to enable the company to protect their position they intend to apply for the necessary powers to supply the electric light. The second statement is a direct contradiction to the first, and we should imagine that they are afraid, otherwise they would not have reduced their price for gas, especially as a large dividend has not been paid for the last year's working.

HOW will the gas companies in the course of a few years fare? Even at present electricity is gradually superseding coal gas, without taking into consideration the probable use of water gas. There is now another competitor in the field under the name of "electric gas." This is produced by converting oil into vapour by means of heat created by passing an electric current through some foraminous metal which offers great resistance to the passage of the current, so that the metal is heated to a very high degree. Crude petroleum is the oil preferred, but other volatilisable substances will answer the purpose. Several electricians at Springfield, Mass., are reported to be hard at work perfecting the process. One of the advantages claimed for this "electric gas" is its cheapness. The estimated maximum cost is 8½d. per thousand cubic feet, the minimum being 6½d. The apparatus is said to be neither bulky nor complicated, and one generator, no larger than an ordinary office desk and very easy to manipulate, will, it is asserted, supply gas for lighting, heating and power purposes for a large factory. This latest Yankee development must be accepted with due caution. When the process is perfected (?) we hope to lay some details before our readers.

THE directors of the Derby Gas Light and Coke Company have just come to the conclusion that they have nothing to fear in the way of competition from water gas or electricity, as they are able to supply coal gas at 2s. per thousand cubic feet. They, however, overlook the fact that the public prefer, and *will have*, as our gas electric contemporary is continually saying, the electric light, notwithstanding the cost. Still, owing to the cheapness of gas in that town, the Midland House-to-House Electricity Company, and the Laing, Wharton and Down Construction Syndicate will, if they obtain powers for the lighting of that district, not find business so remunerative as would be the case had gas been more expensive. Then, again, the local authorities themselves intend to apply for electric lighting powers, so that it is doubtful whether the two companies in question will be able to obtain the necessary permission.

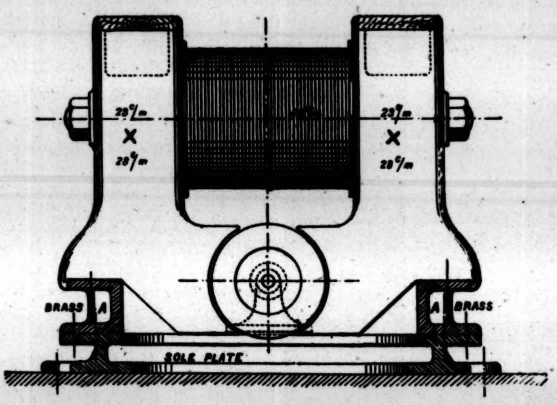
ONLY a few weeks ago we referred to the taking over by the Electric Construction Corporation, Limited, of several concerns already in existence, and we designated the *coup* as the mammoth combination. Our readers will remember that the Julien patents were bought for no less a sum than £40,000, and we asked at the time in what their value consisted that such an enormous sum as this should be squandered in their purchase. This question may be very pertinently repeated on the strength of M. Michelet's report on the Brussels electric tramcars, but we doubt whether we shall receive any answer such as would justify the expenditure. That there were wheels within wheels in connection with some other factors in this combination is well known; and it was at the time also common knowledge in certain financial and electrical circles what the result of the Brussels experiment had been. The buying up of the Julien patents is, under the circumstances, one of those things which no fellow can understand, except on the supposition that the promoter was also the vendor of the Julien patents, which we have reason to believe was the case.

OUR readers will observe that the unit fiend has again been at work in Paris. See page 262. Are we doomed to meet him next week at Newcastle?

SHIPYARD LIGHTING IN BELFAST.

WHILE electric lighting has been making steady progress in England and Scotland, it is satisfactory to know that things have not been standing still in Ireland. In the shipbuilding yard of Messrs. Harland and Wolff, in Belfast, there is installed, if not the largest private arc lighting plant, one with which at least few in this country will compare in point of magnitude. Started several years ago the installation has been added to from time to time according to requirements, the number of dynamos at present numbering no less than 18, and supplying current to a grand total of 95 arc and about 200 incandescence lamps. For lighting shipyards and other places where heavy structural work is carried on the electric light has proved an invaluable acquisition; so much so, that we find it difficult in these days to imagine how the ships of the past could have been built and bridges of the past erected without its aid.

As may be supposed, dynamos have been greatly improved since Messrs. Harland and Wolff put their first ones in, and we find, in consequence, considerable variety in the machines employed. These comprise eight Burgin, two Greenhill, three Manchester, one Brush and two Crompton machines, besides a new one, the latest designed by their own electrician, Mr. C. Esson. All these are series wound to supply the arc lamps, an alternating current machine of the Siemens pattern being used for the incandescence lighting. The latter not being sufficient for all the 200 lamps, part of them is supplied from a set of 54 accumulators, which are charged during the day.



The arc lamps most used are of the Crompton DD type requiring a current of 22 ampères at a difference of potentials of 50 volts. This lamp gives very good results, enduring, without detriment, such rough usage as lamps frequently meet with in shipyards, and being so simple in action that any workman can look after it. The Brush lamp has also a share of the work, but is exclusively used for indoor lighting. It also is found to give no trouble in working.

The arc lamps for outdoor use are erected on latticework poles, each provided with a T iron rail in front, on which a carriage runs to which the lamp is attached. This method of raising and lowering the lamp has been devised by the firm only recently, and is found to be not only cheaper, but in every way superior in working to the older way of raising and lowering on wire guides.

The machine designed by Mr. Esson is shown in the sketch. The output is 22 ampères at a difference of potentials of 440 volts with a speed of 450 revolutions per minute. It is series wound, and supplies current for eight Crompton DD lamps. The armature core has an outside diameter of 28·52 cm., an internal opening of 15·87 cm., and is 27·74 cm. long. It is built up of annealed charcoal iron wire 1·6 mm. diameter insulated with black japan varnish, the total cross-section of actual iron being 264·3 square centimetres. The armature is wound in 52 sections, each containing 21 turns of ·072 inch diameter wire. The aim in designing the field magnet has been to get the magnetic circuit as short as possible. Two pole pieces of special cast iron are mounted on gun-metal brackets, A, A, the latter being attached to the cast iron sole plate. The wrought iron magnet core is 22·8 centimetres diameter, and has a cross-section, therefore, of 410·329 square centimetres. It is wound with 1,545 turns of ·148 inch diameter wire. The magnets are bored out to 30·79 centimetres, each pole embracing 120° of the armature circumference. The bearings are of phosphor bronze and fitted with save-alls and reservoirs for the oil passing through them. There is no sparking whatever at the brushes.

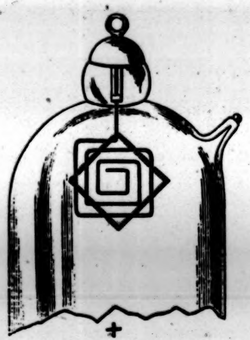
During the summer season the generating plant has been improved by substituting in the Burgin machines for their original armatures new ones of the Gramme type, made by the firm's electrical staff. These were designed to do the same work at a slower speed, and are built of annealed iron wire, and are found to give much better results than the old armatures, the heating being greatly reduced and the speed much diminished. Thus, as a result of lessening the air gap and increasing the section of the core, the speed for the same output as formerly is now 1,006 revolutions instead of 1,242, using less weight of copper.

Extension is going on, and there will be shortly installed 50 additional arc lamps, erected by the firm's staff, which will be supplied with current from two Crompton dynamos of 25 lights each. Each machine will be driven by a Tangye vertical engine, to the flywheel of which it will be directly belted. Automatic regulators will be fitted on the dynamos, which will alter the position of the brushes on the commutator, and hence the E.M.F. according to the requirements of the circuits. Seeing there are 25 lamps on each circuit a duplicate line has been erected, by which any section of five lamps can be cut out in the event of a fault occurring. This minimises the chance of a total breakdown for any length of time. The whole of the circuits belonging to this installation are completely under the control of the attendant, who can, at the switchboard in the engine room, connect any circuit to any dynamo or couple up the machines in series if necessary.

CURIOUS EFFECTS OF METALLISATION IN A VACUUM.

IN the *Revue Internationale de l'Electricité*, "G. M." writes as follows:—"We have received from M. Gaston Seguy, who is not only a very clever glass blower, but also an intelligent observer, two samples of tubes in which the volatilisation of metals in a vacuum by the passing of the electric current has given rise to some curious phenomena, which we are unable to explain satisfactorily. We therefore confine ourselves to submitting to our readers the result of these experiments, hoping that perhaps one of them will be able to indicate on what theory we can base our facts.

"A glass tube 3 centimetres in diameter is closed at the two extremities, and to each end is soldered an electrode of platinum or copper of the form shown in the adjoining figure. Through a nipple on the side of the tube a vacuum equal to that of the Geissler tubes is produced by means of a mercury pump; then the current of a powerful induction coil (·3 metres spark at least) is passed through. The metal is then volatilised at the negative pole and is deposited on the sides of the glass producing a black discoloration for platinum and yellow for copper. The metallisation of the sides of the tube is more rapid in proportion as the diameter is smaller. But in any case it produces this curious phenomenon to which we wish to call attention: it does not take place at all on either side on that part of the tube placed directly opposite the plane of the electrode, as we can easily see by placing the tube before a sheet of white paper. The reservation thus obtained exactly reproduces the external form of the electrode; but what is still more curious is, that the angles of this outline do not correspond to the angles of the electrode, but come opposite the straight lines as shown in the accompanying figure. These are phenomena similar to those observed by Crookes, Jamin, and Goltein, and we think that in order to facilitate an explanation of them, it is better not to pass them by in silence, but on the contrary, to note them with all their peculiarities every time we observe them." G. M.



A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 65.)

VI.—ARMATURES IN PRACTICE—(*continued*).

If the armature is divided diametrically by a line perpendicular to the direction of the lines of force crossing it, in all the exterior conductors on one side of this line, the E.M.F. will be in the same direction, while in all those on the other side of it, it will be in the opposite direction. The sections being wound so as to form one continuous helix the E.M.Fs. induced in the separate convolutions of each half of the armature are added, the total E.M.F. furnished by the two halves in parallel being obtained at the brushes when no current is flowing. When a current flows the difference of potentials at the brushes is this E.M.F. *minus* that absorbed in sending the current through the armature resistance. Thus in a 2-pole field the directions of induction are divided by one diametrical line, but if the ring is placed in a 4-pole field as in fig. 123, two diametrical lines, *a*, *b* and *c*, *d* divide the directions of induction. In all the wires between *a* and *c* the induction is in one direction, while in those between *c* and *b* it is in the opposite direction. Again, in those from *b* to *d* it is in the same direction as from *a* to *c*, and from *d* to *a* in the same direction as from *c* to *b*. In the four quarters of the winding there are induced equal E.M.Fs. which in those quarters opposite each other are in the same direction, while in opposite directions in adjacent quarters. To collect the current from a ring armature thus placed in a 4-pole field there must be four positions of collection situated at *e*, *f*, *g* and *h*. The current leaves the two brushes, *e* and *g*, and returns by *f* and *h* flowing through the armature in four parallels from *f* and *h* to *e* and *g*, these opposite brushes being joined together. If N be the lines of force proceeding from one pole, obviously in one revolution, each conductor cuts 4 N lines. If *s* is the number of revolutions per second, the lines cut in a second are 4 N *s*, the average E.M.F. in volts induced in each exterior conductor being therefore $= \frac{4 \text{N} s}{10^8}$. The total E.M.F. is due to one-fourth of the conductors since they are connected in four parallels, and accordingly the E.M.F. of the machine is

$$E = \frac{4 \text{N} s}{10^8} \times \frac{\text{W}}{4} = \frac{\text{N} s \text{W}}{10^8}.$$

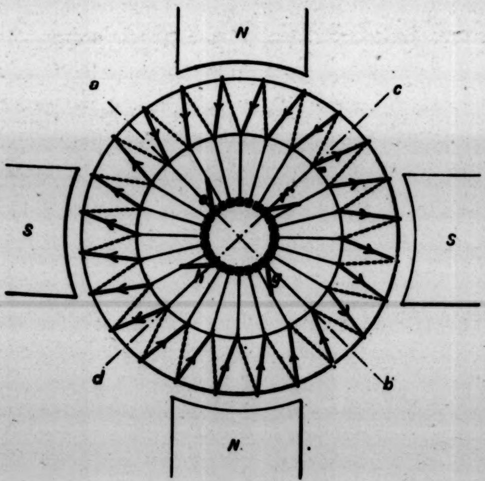


FIG. 123.

It will be seen that this expression is the same as that which was obtained for the E.M.F. of the 2-pole machine. By reason of there being four poles there now occur in each conductor two induction cycles per revolution instead of one. But since the conductors are in four parallels instead of two, the E.M.F. for the same number on the exterior remains as previously. It should be mentioned, however, that the wires in four parallels are capable of carrying twice the former current. If we placed the ring in a 6-pole field we should have three equidistant diametrical lines dividing the directions of induction and six positions of collection for the brushes, while in an 8-pole field there would be four dividing lines and eight positions of collection.

It will be observed that in the 4-pole machine, fig. 123, in consequence of the opposite brushes, *f* and *h*, *e* and *g*, being connected together, opposite segments of the commutator are virtually connected. When the current from the machine is of such magnitude that it may be readily collected by two brushes, it is usual to connect opposite commutator segments in the winding, thus dispensing with two brushes and collecting by the remaining two placed at positions on the commutator 90° apart. The brushes, *g* and *h*, in fig. 123 would in this case be removed and the brushes *e* and *f* retained. Though there are but two brushes used, there are virtually four positions of collection as before, the only difference being that whereas when four brushes were employed, the opposite commutator segments were connected outside the armature, now that two brushes are used they are connected inside. This cross connection may be made by joining the conductors going to opposite segments of the commutator by copper strips or wires, as shown at *a* and *b*, fig. 124. In the diagram four segments of a commutator, A, B, C, D, are shown

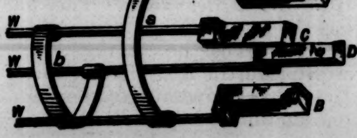


FIG. 124.

to which the conductors, *w*, are connected, A being opposite B, and C being opposite D. There must be in the actual connections as many strips of metal as there are opposite segments to join. Another way of effecting the cross connection of the segments is by mounting on an insulating bush fixed on the shaft a number of brass or copper washers, insulated from each other, and having lugs on opposite sides which serve to connect the conductors going to opposite segments. This arrangement is shown in fig. 125, where A, B, C and D represent four commutator segments, and *w* the conductors leading to them. Two washers, *a* and *b*, having the conductors soldered into their lugs, as shown, connect the segments, A, B and C, D, together. Care must, of course, be taken to insulate the connecting pieces so that only the conductors intended to be joined shall be in contact. If the armature is intended to run in a 6-pole field and cross connections are employed, the segments 120° apart must be connected in sets of three. If cross connected for an 8-pole field, the segments 90° apart are joined in sets of four. When the current is large it is usual to collect by as many sets of brushes as there are positions of collection, there being required to obtain good results a brush surface corresponding to the magnitude of the current flowing.

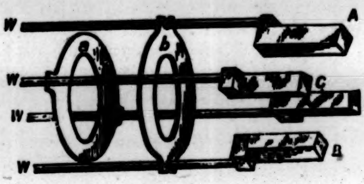


FIG. 125.

(*To be continued.*)

CONTINENTAL NOTES.

[FROM A CORRESPONDENT.]

THE City of Rouen has just successfully carried out some experiments for the electrical treatment of sewer water. The motor force was obtained by a steam engine working a low tension Phœnix dynamo giving 1,200 ampères the pump to raise the sewage waters into the reservoir destined for electrolysis, and the float boards for agitating them. The negative electrodes were formed by zinc discs fixed on a slowly moving horizontal shaft; the positive electrodes were formed by platinum plates in ebonite frames. Half of its weight of common salt was added to the water.

The Company for the Transmission of Power by Electricity has now finished the electric lighting of the Grand Boulevards comprised in its section of Paris. This lighting includes 27 arcs of 10 ampères divided between the Place de la République and the Porte St. Denis, and placed at the top of candlebra in lamps of clear glass. It is fed altogether by the two stations of this company, and already installed at 70, Rue de Bondy and Rue des Filles Dieu. The following are short details of the two stations. Rue de Bondy: This station at present serves the Ambigu, Folies Dramatiques, Porte St. Martin and Renaissance Theatres. For this lighting it has two semi-fixed horizontal Weyher and Richemond engines, each of 75 horse-power, working four dynamos of 250 ampères and 120 volts; two Leconteux engines of 70 horse-power, each working two Thury dynamos giving 500 ampères and 120 volts at a speed of 375 revolutions; and, in addition, eight tons of accumulators. In view of public lighting, four groups have been installed, each group composed as follows: A Weyher and Richemond motor of 140 horse-power, and a dynamo giving 750 ampères under a mean tension of 140 volts at a speed of 300 revolutions per minute. Accumulators are also employed for public lighting; their total weight is 75 tons, and they can furnish 1,000 ampères and 135 volts. Rue des Filles Dieu: This station will include two Weyher and Richemond motors of 120 horse-power, each working a Marcel Deprez of 100 electrical horse-power. These two stations are joined to the distribution canalisation by 13 feeders, seven for the Rue de Bondy and six for the Rue des Filles Dieu. Distribution is made at 120 volts by two trunk lines and feeders, which allow of placing two regulators in series concurrently with incandescent lamps of high resistance; the loss is 1·5 volts in the distributing line and 12 volts in the feeders. The supply is made in part by dynamos and partly by accumulators. The advisability is being considered of establishing other stations, which will receive from the central works of St. Ouen high-tension current which will transform it into low tension current of 130 volts.

At the last meeting of the French Academy of Sciences, M. de Lacaze-Duthiers read a paper on the installation of the electric light at the Roscoff Zoological Observatory; and M. Mascart gave the Academy some particulars of the lightning shock at the Eiffel Tower. The tower was not attacked, and the attendant felt no shock. The point of the lightning conductor had been unscrewed some days previously to be repaired, and the bronze screw which fixed it alone received the lightning, which followed the conductor very regularly till it spent itself in the earth. The attendant saw a light without experiencing the least shock.

The *Revue d'Hygiéne* thus summarises a work of M. Maklakoff, of Moscow, on the influence of the voltaic light on the integuments of the human body. At Kolomno, three hours distant from Moscow, there is a large factory where metal soldering is carried on by means of the Bernados process. The current is produced by 500 Planté accumulators, equivalent to 110 volts and 750 ampères. The voltaic arc is 5 centimetres between the two points; it has a temperature of 3,000° to 6,000° C.; it melts metal with indescribable rapidity, like the flame of a blow-pipe would melt a piece of wax. The caloric radiation of the arc is so weak that at a distance of about four yards the thermometer only rises two degrees in 10 minutes, and yet the effect of the caloric radiation produced by the molten metal is much more than the caloric effect of the voltaic arc. But the luminous intensity is such that the most radiant sun looks like a gas burner by the side of an electric lantern. The workmen preserve their eyes during work with glasses, the grey tint of which is obtained by a combination of green and red; these glasses are so dark that they scarcely permit of the sun's disc being seen through them. They protect the sight very well, but the hurtful action of the electric arc is such that, despite very high wages, it is only with difficulty that workmen are found who will consent to work at electric soldering for two hours a day. M. Maklakoff has assisted at these operations, and has subjected himself to the experiments. He exposed himself directly to the voltaic light of 250 to 500 accumulators for about ten minutes, in the course of a total period of an hour and a half passed in the workshops. Two hours later he experienced a very lively sensation of tingling and itching, of burning of the eyes and skin, which in the evening became intolerable. Cold in the head, with wateriness of the eyes, tumefaction and red coppery tint of the skin of the face, neck, and hands; chemosmosis of the pupils. Bad night, with intense fever; the next day increase of the œdema of the hands, face, neck, skin, and pupils. The third day there was an increase of the brick-like tint of the skin, which commenced to crack and peel off. The author compares this tint to that of a copper saucepan on which collodion had been applied which was coming off. The eye troubles and the chemosmosis disappeared at the moment when a muco-purulent secretion of the conjunctiva was made. Ulterior desquamation of the skin, as in erysipelas. According to M. Maklakoff, the action of the voltaic arc would only take effect on the skin of the eyelids and the bulbous conjunctiva exposed to the chemical action of the rays. The caloric rays would go for nothing. He proposed the employment of a yellow veil of gummed taffeta, fixed on a hoop going round the head, the hoop furnished with a visor similar to that of a helmet, and supplied with a plate of grey glass, obtained by a combination of red and green. This large visor rises on the forehead like enormous eyeglasses when it is not in use to protect the eyes from the voltaic light. The apparatus appears light, practical, and is in no way ridiculous; it covers the neck, but not the hands, which must be protected by gloves, if one wishes to avoid "electric sunstroke."

AMERICAN INTERNATIONAL ELECTRICAL CONFERENCE OF 1892.

At the meeting of the Council of the American Institute of Electrical Engineers, held in New York, August 6th, a resolution was adopted for the appointment of a committee of five, to be appointed by the president, to formulate a plan of organisation for an International Electrical Convention, to be held in that country during the season of the World's Fair of 1892. At the meeting of Council, August 14th, the committee was enlarged to fifteen and its work more specifically defined. The secretary was instructed to communicate at once with President Mascart, of the Electrical Conference at Paris, informing him of the action of the Institute, and suggesting that the work of the present conference be taken up at the proposed convention of 1892.

Vice-President Francis R. Upton, of the Institute, has also been requested to use his influence to secure the official sanction to an adjournment of the conference to meet in this country (America) in 1892. President Elihu Thomson will in the course of a few days announce his appointments on the committee of fifteen, and the work of organisation will be taken up immediately. The various electrical organisations throughout the country will be invited to co-operate.

THE NEW JULIEN ELECTRIC CAR.

The *Electrical World* (New York), of August 24th, describes the new storage battery car of the Julien Electric Traction Company, which has been specially designed for the Fourth Avenue Road, embodying all the improvements suggested by this company's long and successful application of the storage battery for electric traction purposes over the above road. The car is very handsome, and is tastefully constructed and finished, surpassing in comfort all previous attempts in the line of electric cars.

This standard type is made with a 16 feet body, supported on an independent, rigid truck, with a 6 feet wheel base, weighing, with motor, gearing, and one set of batteries, about 7 tons. This, however, varies in accordance with the weight of batteries required to suit the requirements of each particular road. The car body is perfectly independent of the truck, and can be quickly removed to make repairs or for inspection. The motors are two in number, one on each axle, and each of 10 H.P. capacity; this being a suitable power for ordinary street car work, where the grades do not exceed 5 or 6 per cent., and are not over 800 feet in length. The current is supplied by two sets of batteries, each set containing 108 cells, one set being charged while the other is in service, the change between the two being effected in from 4 to 8 minutes. The cells are placed in six trays on each side of the car, and are inserted in it by pushing them from the outside through the open panels under the seats. The batteries are generally so proportioned that the amount of energy contained is at least double that required for each trip. The system of battery shifting devices employed enables 15 cars to be operated from one battery rack, which occupies a floor space of 24 feet by 7 feet on each side of the car. The stall room for 135 to 150 horses (9 or 10 horses to the car) would be 5,400 square feet. Each car requires from 6½ to 8 H.P. for generating machinery, depending on the number of cars in operation. The car is operated from either end by means of a "regulator," the speed being varied at will. A special and powerful brake apparatus is used on all cars, but in cases of emergency the regulator is reversed, and the car stopped suddenly by electric power. The cars are lighted by electricity, and the warning gong is also sounded by the same agency.

The cars on the Madison and Fourth Avenue line absorb one electrical horse-power hour per mile. This road has some long gradients, the one at Centre Street being 600 feet in length, and the grade over 4½ per cent. On this road the cars are furnished with 108 cells of battery, which, with the containing rubber cells and trays, weigh about 3,800 pounds, and have a capacity of 35 electrical horse-power hours. The speed of these New York cars is from 9 to 10 miles an hour on the level. The cars can be geared to run much faster for suburban traffic, but the ordinary demands of city traffic call for no greater speed, especially when the cars run between horse cars.

It has been adequately shown, during the last six or eight months, that these cars are capable of performing efficient service, and that the system is practical, reliable and economical; so that the Julien Electric Traction Company will guarantee their cars to do efficient service, and that the cost of motive power will not exceed that of horse traction.

A car which was placed in regular passenger service on February 23rd, 1889, ran, up to June 22nd, 6,706½ miles. Being assured, by the working of this car, that the standard of efficiency and reliability aimed at had been obtained, work was commenced on building thirty new cars at the works of the John Stephenson Company, twenty of which are now being put in service on the Fourth and Madison Avenue line, in this city. The reliability of the system is well shown, for since the cars began to take passengers, on September 15th last, they have never broken down, but have always returned to the station with their own power. Mr. Alfred Skitt, the superintendent of the New York and Harlem Railroad Company, states that his company are well pleased with the operation of the Julien cars, and especially with the very marked improvement in the new cars, and that there is no longer any doubt concerning the economical working of storage battery cars. They propose to thoroughly test the system during the coming winter.

Those who have not seen the cars work in ice and snow will understand the reason of their success when attention is called to the fact that these cars are simply locomotives. Their weight gives them adhesion, and the enormous amount of stored energy, at the disposal of the driver, propelling power. In addition, the batteries being grouped in several series, the driver is enabled to increase the pressure from 54 to 216 volts.

With reference to cost of operation, motive power is estimated at $3.40 for a car day of 75 miles, that is to say, the cost of energy is two cents per horse-power hour, and $700 per annum for maintenance of batteries and motors. As regards the life of the battery there is no reason why the two sets should not last two years. The chief element of cost, the raw material, remains to be made over again into new batteries, and the mechanical devices for manufacturing the elements have so reduced the cost of manufacture that that item of expense no longer threatens the economy of the system. The more level the road the cheaper the system. The cost of generating machinery per car will vary with the number of cars in operation. If no more than twenty cars are to be operated, an allowance of $1,000 per car must be made for machinery and shifting devices. If the current is purchased from a central station this item is dispensed with. In conclusion, it is worthy of note that the system may be introduced gradually, side by side with horse traction, thus avoiding heavy initial outlay; also, the ordinary horse cars may be altered to suit the system, although new cars specially adapted for the purpose are decidedly to be preferred.

NOTES ON THE DYNAMOS AT THE PARIS EXHIBITION.

VI.

THE Thomson-Houston International Electric Company has a comprehensive exhibit of dynamos and accessories for central station work. The largest dynamo shown, fig. 1, is of the single horseshoe vertical pattern, this being used as the generator for a motor of similar construction situated about a mile away. The machine gives at its normal speed 125 ampères, at a difference of potentials of 500 volts. It has a drum armature, and the magnets are compound wound, the disposition of the series coils forming the chief peculiarity of the machine. These, as will be seen from the fig., are placed in front of the poles and close to the armature, the shunt coils being wound on the magnet cores in the ordinary way. It must be remembered that in every dynamo the object is to magnetise the armature, and the nearer the magnetising coils can be got to it the better. Were it not for structural reasons, the coils would always envelope the armature, hence it will be perceived that the series coils are placed here in a very advantageous position. In machines with drum armatures the weakening effect of the armature current on the field, which it is the chief duty of the series winding to compensate, is very small, and the turns required are consequently few. It is probable, therefore, that with ring-wound armatures the series winding would become too cumbrous to affix to the magnets in the manner shown.

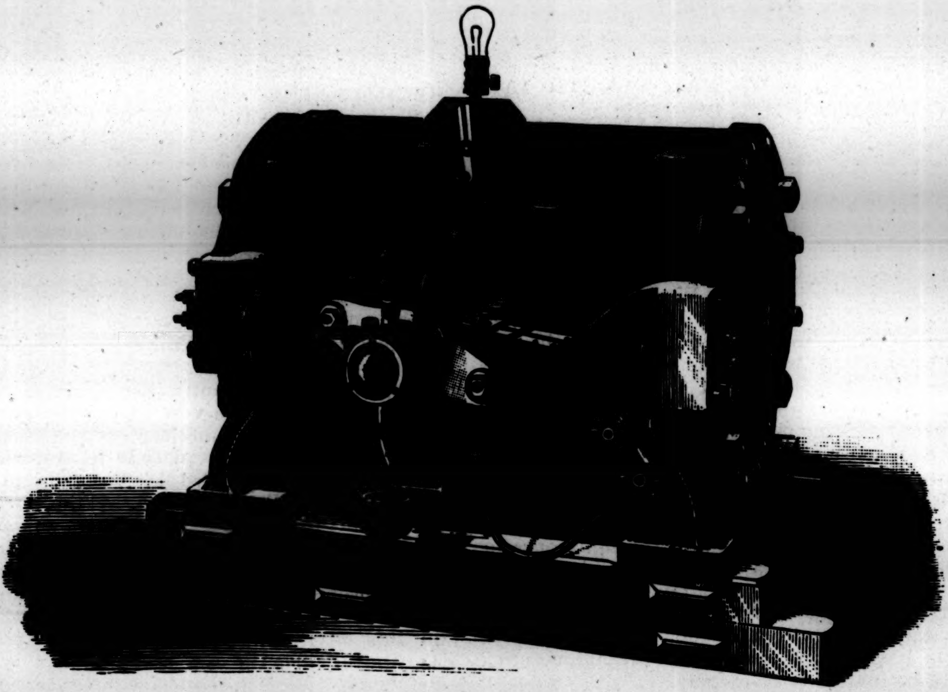


FIG. 6

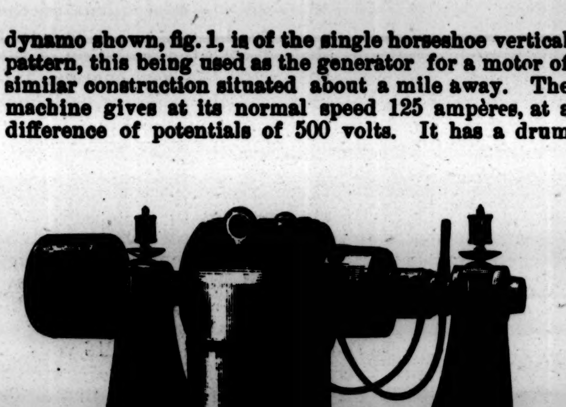


FIG. 1.

The motor to which the current is conveyed is of the same type and size as the machine described, being, however, shunt-wound. It drives an ordinary Thomson-Houston incandescence lighting compound-wound machine, fig. 6, which runs at 1,150 revolutions per minute and supplies current at a difference of potentials

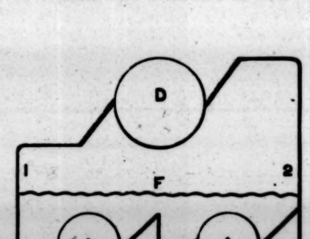


FIG. 2.

of 220 volts. This machine is very like the well-known arc dynamo, having a spherical armature and external yoke bars of wrought iron. The armature is built up of annealed wrought iron washers, carried by hubs on the shaft. It is wound in about sixty sections and connected up to an ordinary Gramme commutator. The magnets are more massive than in the arc dynamo, the series coils being situated in front of the poles and occupying in this machine a position corresponding to that occupied by those in the machine previously described.

For direct supply the current is distributed on a kind of three-wire system to lamps and motors requiring a difference of potentials of 110 volts. In the ordinary three-wire system two dynamos are employed, having each this difference of potentials. In the latter the two terminal conductors are connected to the outside terminals of the machines, and the third, or intermediate wire, coupled to the junction between the two. On the Thomson-Houston plan there are also two dynamos, but they are connected in a different way. The main dynamo, D (fig. 2), supplies current at a pressure of 220 volts to the conductors 1 and 2. Between each of these and the third conductor, 3, the lamps, L_1 and L_2, are placed. As long as there is the same number of lamps on each side of conductor 3, and there flow in consequence on each side currents of similar magnitude, the pressures between 1 and 3, and 2 and 3 remain the same. But if some of the lamps at L_1 are turned out the balance is disturbed, the difference of potentials between 1 and 3 rising and that between 2 and 3 falling. In a general system of distribution where there is no guarantee that the currents required on different sides of the middle conductor will be always of equal magnitude, it is necessary to provide some means of correcting this disturbance, and it is the function of the second, or auxiliary, dynamo to act as a "potential equaliser," and to keep the difference between the intermediate and terminal wires always at 110 volts. The armature of the potential equalised has two windings, each with its own commutator and set of brushes. The field magnet, F, is a shunt to the terminals of the large dynamo, and is therefore excited with a constant current. The two armature windings represented by A_1 and A_2 are joined in series, as shown, the intermediate wire, 3, being connected to the junction between them. Imagining that there is the same number of lamps at L_1 and L_2 the machine is now driven as a motor by a small current in each armature winding, both currents making it run in the same direction. Obviously, since both windings rotate in the same field their E.M.Fs. must be equal. Now, suppose that some of the lamps at L_1 are extinguished, the difference of potentials on that side tending, therefore, to rise, and that on side L_2 tending to fall. The speed of the armature increases, due to the higher difference of potentials on the winding A_1, but A_2 having an E.M.F. higher than the difference of potentials on side, L_2, it becomes a generator on its own account. When acting as a generator the current flows in the opposite direction through this winding, and the difference of potentials is accordingly raised between 2 and 3. We have, therefore, the two windings of the armature acting as motor and generator on the sides of less and more lamps respectively, the potential on each side of the third conductor being maintained practically constant. The small variation due to the resistances of the equaliser armatures is said to be negligible.

For their alternating current system the Thomson-Houston Company employ an alternator having a stationary field and revolving armature. The machine in appearance and structure resembles that of Stanley (Westinghouse) which we described some time ago,* the armature coils being laid upon the outside of a cylindrical core and the magnet yoke, which is bolted to the bedplate, being in the form of a ring surrounding the armature from which project radially the magnet cores carrying the exciting coils. The armature core is supported by a spider having its arms slightly twisted, whereby a draught of air is driven continuously through the central opening.

Two alternators are exhibited differing from each other in the manner of exciting the field magnets. The first is self-exciting, two wires from one of the armature coils being connected up to alternate plates of a 10-part commutator from which the current is led through brushes resting thereon to the magnetising coils. There are 10 coils on the armature of rectangular shape wound with square wire one layer thick. Surrounding the armature are 10 radial magnets arranged with their alternate poles facing the armature. The speed of the machine is 1,500 revolutions per minute, which gives, therefore, 125 induction cycles per second. The current is 20 ampères at a difference of potentials of 1,000 volts. Total weight 3,300 lbs.

The second machine has its magnets wound so that the difference of potentials at the terminals rises as the lamp load increases. This result is produced by separately exciting eight out of the ten field magnets, and sending the whole current of the machine when commutated through the remaining two. The connections employed are shown in fig. 3. A is the armature of the alternator from which the current is led to the insulated ring, R_1, thence flowing by the brush resting on it to the outside part of the circuit and returning by a second brush to the insulated ring, R_2. From this a wire is led to the 10-part commutator, C, making connection with its alternate segments. The commutated current now flows from brush, D, through the two field coils, F, returning by brush E to the commutator, and thence led to A by a wire, W, connected to the alternate segments of C. Thus two of the magnets are excited

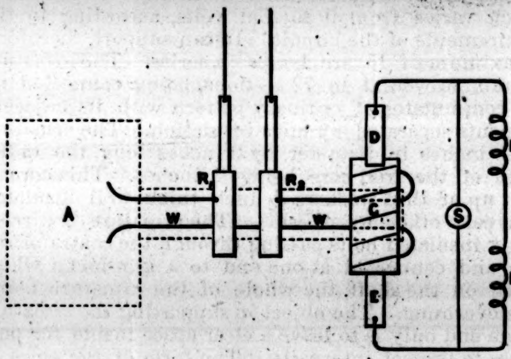


FIG. 3.

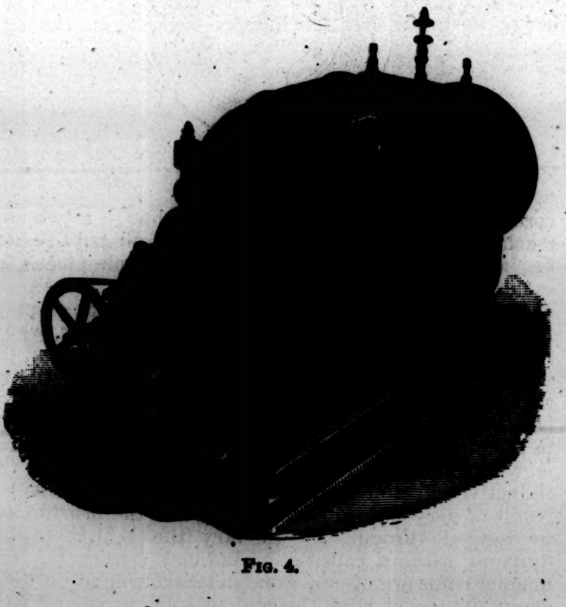


FIG. 4.

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* See ELECTRICAL REVIEW, Vol. XXI., p. 334, 1887.

by the full current of the machine commutated so that it flows in one direction between D and E. The excitement given to the magnets is thus increased with the load, the difference of potentials therefore rising to make up for the additional E.M.F. absorbed in the mains. S is a shunt by which adjustment can be effected if something less than the full current is required for compensation. Once adjusted for the particular circuit on which the machine is to be worked it requires no further attention. The current is delivered by this machine at a difference of potentials of 300 volts, and is distributed to lamps of 75 volts by a double three-wire system. A "compensator" is fixed at the central station from which the distributing mains start, the function of which is to maintain the difference of potentials constant when the balance on the distribution mains is disturbed by turning out lamps.

The Sperry Electric Company exhibits their dynamo for arc lighting, which is illustrated in fig. 4. The machine, which is series wound, gives, at its normal speed of 1,150 revolutions per minute, a constant current of 10 ampères at a difference of potentials which varies from 0 to 750 volts, according to the requirements of the circuit. It can support, therefore, a maximum of 15 arc lamps in series. The armature is Gramme wound in 72 sections, being connected up to a commutator of ordinary pattern with its adjacent segments separated by mica insulation. The armature is 14 inches in diameter by 9 inches long, the radial depth of the iron core being 2 inches. This core is built up of thin washers $\frac{1}{32}$ inch thick well insulated from each other by asbestos. The armature is carried by six insulated bolts passing through the centre of the core, and connected at one end to a gun-metal wheel keyed on the shaft, the whole of the armature being thus overhung. The object in supporting the armature at one end only is to leave a clear space inside for pole pieces to project internally. The form of the poles is more clearly seen in fig. 5, each piece dividing so as to form a pair of jaws between which lies the armature core. It will be observed that this, though a two-pole machine, has four magnet limbs and four pole pieces, *i.e.*, a pair of magnets and a pair of pole pieces for each pole. It is well known that so far as the mere production of a magnetic field is concerned the employment of multiple magnets is wasteful; but here, where there has to be produced a particular *distribution*, the wastefulness becomes of secondary importance. Owing to the lines of force entering the pole pieces in the positions shown, and due to the particular shape given to them, the E.M.F. furnished by each armature section is when running, nearly uniform. The ratio of the inductive effect of field and armature is said to be the result of very careful experiments, and the brushes can be rotated through 90° to vary the E.M.F. of the dynamo without causing prejudicial sparking. The magnet cores are of cast-iron, and have wound on them about 200 lbs. of wire, the armature being wound with 36 lbs. of ·058 inch diameter.

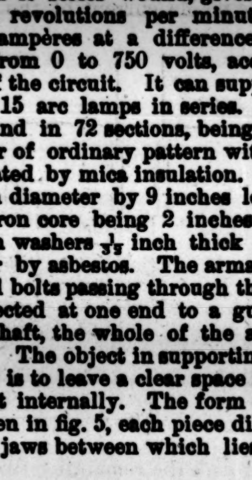

FIG. 5.

To the left of fig. 4 will be seen part of the automatic regulator which is driven from the dynamo shaft. It is the function of this apparatus to rotate the brushes on the commutator in accordance with the E.M.F. requirements of the circuit. On the regulator spindle is an eccentric which gives reciprocating motion to a bar carrying two pawls, pivotted on opposite sides and connected by a cross link, so that both move together. Between these pawls is a bar with teeth cut in opposite directions on its opposite edges, and placed so that either of the pawls may engage with it as the link connecting them is raised or lowered. On one end of this bar is cut a rack gearing into a toothed wheel on the brush-holder, consequently the raising or lowering of the link causes the brush-holder to be rotated in one or other direction. If the link remains in mid position, neither of the reciprocating pawls engage the rack bar, the brush-holder consequently remaining at rest. This mechanism is electrically controlled in the following manner:—Pivotted near one of the poles is a piece of iron on which the field magnet produces a certain pull, which is counteracted by a spring. If the current increases, this piece of iron approaches the magnet, and in so doing moves by suitable levers the link connecting the pawls, thus causing one or other of them to gear into the rack bar, and so move the brush-holder. If the current diminishes, the iron piece recedes from the magnet, and the brush-holder is moved in the opposite direction. If the normal current flows neither pawl gears into the bar, the link being in mid position. The pull of the magnet depends not only on the current flowing, but on the position of the brushes on the commutator, the inductive effect of the armature on the field being determined by this. It is found that as the brushes are rotated the pull of the magnet for the normal current diminishes, and accordingly there is fixed on the brush-holder a cam which, as it moves round, reduces the pull of the counteracting spring by a corresponding amount. Thus the piece of iron is maintained in the same position for the normal current, whatever the lead of the brushes.

(*To be continued.*)

INTERNATIONAL CONGRESS OF ELECTRICIANS HELD AT PARIS, 1889.

SESSION OF AUGUST 27TH, 1889.

First Section.—Units, Measures.

M. **VAN AUBEL** laid before the Congress the bismuth spirals of MM. Lenard and Howard, and Prof. K. Angström's apparatus for measuring the intensity of magnetic fields. He showed that the relation between the intensity of the magnetic field and the increase of the electric resistance is unknown, since we can employ neither the formula of Leduc nor the laws of Righi and Goldhanmer. A calibration of each spiral is therefore necessary. M. Van Aubel demonstrated that the spirals of Lenard and Howard can nevertheless be employed for industrial trials, and especially in the case of narrow and limited magnetic fields.

He then described the apparatus of Angström, and recommended the methods of Profs Stenger and Angström, which give a much greater precision than any others.

M. Szarvady said that the Congress of 1881, whilst adopting practical units, did not concern itself about a practical unit of the magnetic field. This was probably because the consideration of a magnetic field had not yet entered into the sphere of practice. This is now no longer the same, and it would be desirable to select a practical unit for the magnetic field, and to give it a name.

We propose to define the unit of the magnetic field as that of the uniform field, which would be produced by an electromotive force of 1 volt in a conductor of 1 centimetre in length, intersecting normally the lines of force at the speed of 1 centimetre per second. ($E = H L V$).

This unit will be equal to 10^8 units C.G.S.

The usual magnitudes of the magnetic field being considered as comprised between 100 and 15,000 units C.G.S., the proposed unit would be too large, and the unit commonly employed would be the sub-multiple $\frac{1}{10^6}$ or the *micro*, a practical unit which would be 10^2 C.G.S. units.

The choice of a practical unit of the magnetic field involves that of a practical unit of the flow of force $HS \left(B = \frac{HS}{T}\right)$ which would = 10^8 C.G.S. units.

Here, again, the customary unit would be the sub-multiple $\frac{1}{10^6}$ of the unit.

We propose the names—*Gauss*, for the unit of the intensity of the field; *Weber*, for the unit of the flow of force.

M. Curie considered that the system was not coherent.

M. Guillaume spoke on the necessity of adopting a practical C.G.S. of pressure.

The theoretic unit is the dyne, *c m*, for which we substitute the megadyne, *c m*². The pressure exerted by a column of mercury of 1 cm. at 0°, situate at 45° (lat. ?) and at the level of the sea is, according to the best determinations:

$$15{\cdot}5956 \times 980{\cdot}63 = 13332{\cdot}25.$$

A megadyne, *c m*², is therefore given, under the same conditions by a column of mercury of 75·006 cm. The uncertainty of this number being about $\frac{1}{10000}$, we do not deviate from permissible conditions if we adopt as a practical unit the pressure exerted by a column of mercury of 75 cm. in height. M. Guillaume proposes for this unit the name of *baris*.

M. Guillaume further made a communication on the unification of notations. He referred to the decisions taken by the International Committee of Weights and Measures, and proposed the adoption of an analogous system for mechanical and electrical units.

This system would consist in designating each of the units: *dyne, erg, baris, watt, volt, ampère, farad, coulomb, joule*, by two initials in small Roman type; the ohm would be designated by ω, the customary multiples and sub-multiples would be the following: mega, M; kilo, *k*; milli, *m*, and micro, μ.

M. Moser proposed to adopt under the name of *trop*, or some other, a unit of entropy defined by the formula:

1 joule = 1 trop × 1 degree C, analogous to the equation:

$$1 \text{ joule} = 1 \text{ coulomb} \times 1 \text{ volt}.$$

M. Violle proposed that the candle employed in electric measurements as the usual photometric standard, should be taken equal to $\frac{1}{20}$th of the absolute unit of light adopted by the International Conference of 1884. This candle, approximately equal to $\frac{1}{10}$th carcel, should be called the *decimal candle*. The proposal was unanimously adopted.

M. Hospitalier proposed to add to the electric units already adopted, independently of the watt and the joule, a unit of specific resistance and a unit of coefficient of self-induction. Referred to the Commission of Units.

M. Zeuger made a communication on bipolar induction in a revolving sphere, and described an apparatus to imitate the movements of the planets and the units of their orbits.

Second Section.—Industrial Applications.

The President announced that the special commission chosen to examine the communication of M. Orava, on the photometry of incandescence lamps, has concluded that:—The degree of incandescence of a lamp is the quotient of the intensities (in carcels) of the radiations of the wave length $\lambda = 582$, and of radiations of the wave length $\lambda = 657$.

The wish was expressed that the indication of the luminous power of a lamp should be accompanied by that of the degree of incandescence to which this power corresponds.

It was also wished that if this power is given in candles it should be in decimal bougies, in value $\frac{1}{20}$th of the absolute standard of light defined by the Congress of 1881.

M. Orava summed up the chief points of the method which he proposed. He described especially the composition of the wave length 582. He takes 22·321 grms. ferric chloride, and 27·191 grms. pure crystallised nickel chloride. The whole is dissolved in distilled water at 15° C. The liquid must not be filtered, and it must be saturated with chlorine. The second experiment, intended to give the tint, is made with a red glass transmitting the wave length 657.

M. Macé de Lépinay finds a relation between the total intensity of a luminous source and the photometric comparisons between the red and the green radiations. This relation is the following:

$$1 = A\,a + B\,b,$$

1 being the total intensity, A and B the intensities of the red and the green rays, *a* and *b* the coefficients to be determined experimentally.

Prof. Silvanus P. Thompson made a communication on continuous current transformers. If we call e_1 and e_2 the differences of potential at the limits of the primary and secondary circuit, E_1 and E_2 the electromotive forces developed in the primary and secondary circuits,

ω_1 and ω_2 the angular velocities,

ϕ_1 and $\frac{\phi}{2}$ the currents traversing the two circuits,

C_1 and C_2 the numbers of the exterior conductors of the primary and secondary circuits,

R_1 and R_2 the resistances of the armatures,

i_1 and i_2 the intensities of the primary and secondary circuits. We have

$$e_1 = E_2 - R_1\,i_1$$
$$E_1 = \omega_1\,C_1\,\phi_1$$
$$E_2 = \omega_2\,C_2\,\phi_2$$
$$e_2 = E_2 - R_2\,i_2$$

For a good machine

$$\phi_1 = \phi_2 \text{ and } \omega_1 = \omega_2$$
$$\frac{E_2}{E_1} = \frac{C_2}{C_1}$$

If we neglect the phenomena of hysteresis, Foucault's currents, &c., we have approximately

$$E_2\,i_2 = E_1\,i_1$$

whence

$$\frac{E_2}{E_1} = \frac{C_2}{C_1} = \frac{i_1}{i_2}$$

and finally

$$e_2 \doteq e_1\frac{C_2}{C_1} - \left[R_2 + R_1\left(\frac{C_2}{C_1}\right)^2\right] i_2.$$

or

$$e_2 = e_1\frac{C_2}{C_1} - \left[R_2 + R_1\left(1 + \frac{P_1}{E_2\,i_2}\right)\right] i_2.$$

P_1 being the electric power furnished at the primary circuit.

Prof. Silvanus Thompson mentioned that continuous current transformers are in use at Ipswich; the difference of potential at the extremities of the primary circuit is 1,500 volts and at the secondary 100 volts. Everything indicates that they will quickly receive a great industrial development.

M. Maurice Leblanc spoke about motors with alternating currents. The ordinary dynamos with alternating currents used as recipients require to be primed and to turn synchronically. If they are over-loaded they give dangerous currents. The Elihu Thomson and Tesla motors give a small yield in consequence of self-induction.

The speaker reduces these injurious effects in his motor, which is composed of a fixed annular armature, in the inside of which there revolves a Gramme ring forming the inductor.

M. Gisbert Kapp, on the contrary, considers that the ordinary alternating dynamos are satisfactory motors, which only take a dangerous speed if loaded triple their normal charge.

Third Section.—Telegraphy, Telephony, Signals.

M. Chaye gave a communication on the utility of an alarm-relay for submarine applications.

Mr. Preece gave a communication in English, which will appear on a future occasion.

M. Merczyng read a paper on a new system of telephony for great distances. The distance traversed was 300 kilometres of iron wire of 5 millimetres in thickness. The transmitters are those of Blake and Berliner, and the recipients those of Ochorowicz and Siemens. The transmitters and recipients are separated from the line by condensers of different capacities which is the essential point of the system. The capacity of the recipient condenser must always be less than that of the transmitting condenser. The line had a resistance of 2,000 ohms and a capacity of 3 microfarads.

M. Pierre Picard discussed the application of dynamo-electric machines in telegraphy. The author has developed a new system in which the use of a single dynamo may be combined with currents taken at variable potentials. He connects one pole of the dynamo with the earth directly, and the other through a resistance called a scale of potentials. Very satisfactory trials had been made at Paris for 12 to 15 months. The scale of potentials was from 5 to 6 ohms, and the current was from 15 to 20 ampères. The economy is indisputable.

The same system is in use in America by the Western Union Telegraph Company, but nothing has been published concerning it.

Mr. Aylmer continued the discussion on behalf of Mr. Preece. The latter made experiments at the General Post Office with a Gramme dynamo. The current was too variable for the Wheatstone instrument. He resumed these trials in 1883 with the intervention of accumulators. At present 220 circuits are supplied by 29 accumulators, which are charged once monthly by the dynamos.

M. Paul Samuel described the new telephonic post of M. Van Rysselberghe for lines with numerous offices.

The system is to be seen in the Belgian section of the Exhibition.

M. Maurice Kohn described a new constant battery. The element is composed of a conical zinc pole placed in a caoutchouc cone. The other pole surrounds the caoutchouc, and the whole is kept insulated by a plate kept in its place by a screw. By means of a second caoutchouc case the whole is placed in a glass vessel containing the liquid.

Mr. d'Infreville pronounced the Callaud battery the best. The glass vessel must be very high; the copper low and vertical, plunging into a strong solution of copper sulphate. No more crystals must be added so long as there are any at the bottom at the vessel. The battery may serve for three years if the sulphate of zinc solution is kept covered with a layer of oil.

SESSION OF WEDNESDAY, AUGUST 28TH, 1889.

First Section.—Units and Measures.

M. Wuilleumier gave an account of the determination of the ohm, which he has effected by means of Lippmann's electro-dynamometric method.

The conductor in question was a plate of German silver of 34·72 metres in length, 1 centimetre in breadth, and 3 millimetres in thickness. Its resistance at 19° C. was found equal to $0{\cdot}301889 \times 10^9$ units C.G.S.

It has then been measured in legal ohms at the International Office of Weights and Measures, by means of three specimens of the standard ohm, grouped in quantity, and found equal to 0·302650 ohm.

Hence was deduced the value of the true ohm, which is represented by the resistance at 0° of a column of mercury of 1 mm^2. in section, and 106·27 centimetres in height.

The sensitiveness of this method may easily reach $\frac{1}{30000}$. Its accuracy is limited only by the perfection with which the bobbins are constructed, each of which has only a single layer of wire. It may be estimated as $\frac{1}{3560}$.

Mr. Preece proposed that the watt or power exerted by a current of 1 ampère in a conductor, between the ends of which there is a difference of potential of 1 volt, should be adopted as the practical unit of power.

The kilowatt is then the ergdix per second which he had proposed in 1881.

He also proposed to take as the unit of illumination, under the name of *lux*, the illumination produced by a carcel at the distance of 1 metre, which is practically the same as that furnished by an English candle at the distance of 1 foot.

M. Piltschikoff admitted that neither the consideration of chemical work, nor the theory of a double electric stratum, suffices to explain electrolysis, but that we must take into account the difference between the potential energies of the molecules of the metal before and after transportation.

M. Reignier demanded a distinct definition of magnetic magnitudes.

M. Lauriel returned to the question of notations and symbols.

Second Session.—Industrial Applications.

Mr. Crompton read a memoir on the general rules to be followed in the establishment of batteries of accumulators destined to supply a central station in the case when the accumulators are placed in series on the line, and where the current is distributed at low tension.

These rules are:

1. A battery of 54 elements should have a capacity sufficient to yield 100 ampères for 10 hours, without the electromotive force falling below 100 volts.
2. This battery should be charged by a current of 200 ampères, and have its charge complete in five hours.
3. In cases of emergency the battery should be able to furnish for half an hour a constant current of 500 ampères without becoming deteriorated, and maintaining at its terminals a difference of potential of 100 volts.
4. The yield should be normal when the charging current is 200 ampères and the discharging current 100 ampères.
5. The connections ought to be made with simplicity, and require but little attention.
6. The battery should be fitted with regulators, so that the electromotive force necessary for charging should never be more than 5 per cent. above the battery E.M.F.
7. The connections between the batteries should be such that a part of plates and even of the elements may be removed for repair, without interruption in working.
8. The insulation of the battery and its connections should be perfect enough to secure a minimum insulation resistance of 10,000 ohms, even in the dampest weather.
9. Each element should be covered so as to prevent the escape of acid vapours whilst charging.
10. The containing vessels should be absolutely unattackable.

With reference to electric lighting, Major-General Webber mentioned that the Electric Power Storage Company, of London, furnishes about 600 ampères with an electromotive force of 100 volts, and feeds 2,000 lamps of 30 volts. The installation comprises eight batteries of 54 accumulators. An experience of five months has shown that the consumption of coal is 5 to 7 kilos. per 1,000 watts-hour.

M. Drzewiecki explained a new chemical theory of leaden accumulators. He declares himself opposed to the theory of double sulphatation.

M. E. Reynier gave a communication on the activity and the work of voltaic elements. M. Reynier showed in figures the relative values of primary and secondary batteries, and indicated a graphic method for representing these values.

M. Arnoux proposed to define the merit of an accumulator as the product of the yield and the specific power.

M. Polak proposed to indicate the constants of an accumulator as follows :—

1. Initial electromotive force and minimum limit to which it can descend at the end of the discharge.
2. Initial and final conventional capacity.
3. Duration of the accumulator not in time, but in ampère hours.

Mr. Crompton observed that the capacity of the positive plate increases with time, whilst that of the negative plate remains the same.

The President suggested that names should be given to the different plates of the accumulator, but no definite conclusion was reached.

M. F. G. Worth handed in a memoir on the electric process for purifying sewage and drinking water, on behalf of the inventor, Mr. Webster.

M. G. Trouvé exhibited a universal dynamoter giving direct readings.

THE MAXIMUM EFFICIENCY OF INCANDESCENT LAMPS FOR CENTRAL STATION WORK.*

THE scope of this paper (says the *Electrical World*) may be inferred from the following extracts: "This question, so far as it has to do with the Edison lamp, is one which has already received such exhaustive treatment by Mr. John W. Howell in his paper before the Institute of Electrical Engineers, April 14th, 1888, and later by the Edison Lamp Company in a paper over Mr. Edison's signature read at the last meeting of this Association, that there would seem to be little left to discuss. An interested listener to Mr. Edison's paper at the last convention and to the discussion that followed it, my attention was particularly called to the apparent unwillingness of the convention to accept the results reached by Mr. Howell and Mr. Edison, though the experimental and theoretical determinations of Mr. Howell were substantiated by the mathematical determinations of Mr. F. E. Jackson, and these same results were found by Mr. Edison's investigation to be reached in practice. Those who are familiar with Mr. Howell's paper will recollect the law as stated by him to be as follows: "The point of maximum efficiency is reached when the lamp bills are about 15 per cent. of the total operating expenses of the station." It is the correctness of this law as applied to central stations that we propose now to consider.

Following out Mr. Howell's line of thought, we find the total cost of operating lamps to be made up of two parts :

1. The cost of current.
2. The cost of the lamps.

This current cost is made up of every expense incurred in producing the current, and properly includes material and supplies consumed, labour, taxes, insurance, salaries, rent, interest, and all fixed charges of every description.

If, however, we examine these items, we shall find that they consist of two distinct classes :

1. Those that vary with the amount of current produced.
2. Those that do not, but are practically constant without regard to the current output.

Thus among those expenses that are practically constant we will find all fixed charges, such as interest, rent, insurance, taxes ; also nearly, if not quite, all the labour and salaries, since a station must always be ready to handle business.

The variable items are supplies such as coal, water, oils, &c., and minor expenses. This latter class varies in practically a direct proportion to the current output.

The lamp breakage varies in conformity with the law obtained by Mr. Howell, that the life of the lamp in hours is equal to the sixth power of its efficiency expressed in watts per candle. Using Mr. Howell's notation, and modifying it to conform to the divisions of cost as given above, we would have :

$$\text{T} = \text{total cost} = \text{C} + \text{L} \text{ where } \begin{cases} \text{C} = \text{current cost,} \\ \text{L} = \text{lamp cost,} \end{cases}$$

and where $\text{C} = \text{C}^t + \text{C}^v$

when $\text{C}^t =$ constant current expenses

and $\text{C}^v =$ variable current expenses.

Or $\text{T} = \text{C}^t + \text{C}^v + \text{L}$.

Also, $\text{T}^v = \text{C}^v + \text{L}$, or total variable cost = variable current cost + lamp cost.

To illustrate how the ratio between the constant and variable parts of the current cost will affect the total current cost under varying current output, we will take two cases of opposite character :

1. A.—Constant expenses large ;
   B.—Variable expenses small.
2. A.—Constant expenses small ;
   B.—Variable expenses large.

A central station belonging to the first class will be one where power is very cheap, or costs nothing at all —owns its water power, for instance—whose plant is well managed, which uses but little oil, &c., and has but few repairs. Under these conditions the total cost will vary but slightly, whether there is one lamp in a circuit or a thousand. But while the total current cost varies but little, the cost per lamp, or per horse-power per hour, will vary largely with the current output.

Thus, suppose 2,000 H.P. hours per month cost $400, of which $360 are for constant expenses and $40 are for variable expenses. Here the current cost per horse-power hour is 20 cents. If, however, we increase the output to 4,000 H.P. hours, the expense becomes $440, of which $360 are for constant expenses, and $80 for variable. Our current now costs only 11 cents per horse-power hour.

A station in the second of the above classes will be one where the fixed charges are small, salaries low, and labour cheap. But fuel and water are high, or perhaps power is rented at a fixed price per horse-power hour, so that the cost increases directly with the output.

Thus reversing our figures about, suppose 2,000 H.P. hours per month to cost $400, of which $40 are for labour, salaries, taxes, &c., while $360 goes to pay for fuel, water, &c., the cost would be as before, 20 cents per horse-power hour.

Increasing the output now to 4,000 H.P. hours, we would have total cost $760, of which $40 would be for constant expenses, while $720 would go to variable expenses. In this case the cost per horse-power hour would be 19 cents, as against 11 cents above, a widely different result.

Hence care must be taken in dealing with the question of cost per horse-power hour under varying output of current, to examine and to divide it into its component, constant and variable elements, and base our determination upon the relative value of each.

This paper was also long and exhaustive. A spirited discussion, participated in by Messrs. Howell, Jackson, McClement, Wirt, Beggs and Smith followed the reading, illustrating the difficulties found in the arrangement of an equitable basis for the calculation of conditions which should govern in central station practice. It was desired that Mr. John W. Howell should take time to consider the subject carefully, and if necessary, formulate a modification of his original paper, which would reduce it to a practical rule for the use of managers of central stations.

ELECTRICITY AS A PROFESSION.

THE overcrowded state of the recognised professions has given rise to considerable anxiety on the part of those who find it necessary to choose some way of making a living. The legal profession is suffering greatly owing to the present congested state, and the same may be said, though in a lesser degree, of the medical. By the rapid development of electricity, however, we have a wide field thrown open, and though some attention has been paid to this, as will be shown by the numbers of students at work in various colleges and workshops, in view of the immediate extension which is sure to take place, we scarcely think it is receiving the attention it deserves. Presumably most of the large towns in England will be lighted shortly by electricity, and after the installation work has been completed there will be required fully competent resident men to take charge of the work and keep the lighting in a satisfactory condition; the expected demand in this direction for men being therefore considerable. The selection of candidates will devolve upon Town Councils and local bodies, who cannot be expected to know much about the needful qualifications, with the result that incompetence may do a great deal to discredit electricity. Such drawbacks will, however, be but temporary, and eventually men with sound practical knowledge will have the best posts with the largest emoluments offered to them. The work of the inspector may not require an abstruse knowledge of the higher technicalities, he will not be expected to advance new theories, and may, like the local practitioner of medicine, rarely travel beyond his own sphere, settling down into a quiet and respectable member of society. Electricity has great and varied branches, and the lighting of England will act as an invigorating stimulant to the various industries in connection with electricity. The use of the motor for workshops appears to be little understood and consequently is rarely adopted. In this branch of electrical power alone there are many opportunities, while another distinct branch will be the application of electricity to purposes of locomotion. In fact, there will be no limit to the application of electricity. But only good men will get good places, and only hard study in both school and workshop will produce good men.

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* Read before the Annual Convention of Edison Illuminating Companies.

Some may be inclined to ask whether it is worth the while of young men to spend the necessary time in acquiring a thorough knowledge and undergoing training, which must necessarily take up a considerable time, seeing that the Liverpool Corporation have recently appointed an electric lighting inspector at the small salary of £150 per annum. Whatever this may be at present, it certainly will not be deemed a sufficient inducement in the near future, and as the demand for men increases a higher wage must be paid. In a large town lighted by electricity, the work and responsibility will be very heavy, and the inspector would require able assistants. Therefore, to ensure good work, a remuneration in accordance must be paid. It is not, however, in inspecting that laurels and emoluments will be earned, but in the higher class of work. The advice we offer to young men who are hesitating about taking up a profession, is by all means take up electricity, but to do so earnestly and with the fixed determination of doing good and conscientious work.

THE TAKING OVER OF THE FRENCH TELEPHONES BY THE STATE.

[*From "Le Soleil," September* 1st.]

THIS (Sunday) morning, at 10 o'clock, the Direction of Posts and Telegraphs, acting in the name of the Government, which wants very much to know what goes over the telephone wires during the period of the elections, will take possession of the twelve agencies created at Paris by the General Telephone Company, and of the nine agencies established at Lyons, Marseilles, Lille, Bordeaux, Nantes, St. Etienne, Rouen, &c., by the same company. The General Telephone Company, no article of its contract with the State obliging it to cede the premises occupied by it, will energetically protest against a violation of domicile which will be made in this way. Further on will be found a notice of the company informing its subscribers "That it will do all it can in order that they shall not suffer in consequence of the difficulties existing between it and the Administration." With much correction, the company declares that it does not believe it necessary to enter into an *exposé* of these difficulties. We have not the same reasons for keeping silent, and we believe it will be interesting to show with what lightness the State overrides its contracts, and in what an unceremonious manner it breaks them.

In 1884, the Minister of Posts and Telegraphs authorised the telephone company to establish lines in Paris and certain towns of France. This authority, granted for five years, should expire on September 8th instant. The agreement to which the telephone company entered into contained an article worded as follows:—"The Government may, at any time, purchase the rights resulting for the authority granted and the *matériel* of the undertaking at a price which shall be fixed by a common agreement, and, in default of that, on the valuation of experts."

When the taking-over project came before the Chamber it was thought that a credit of ten millions would be amply sufficient. Out of that sum five millions should be devoted to the purchase of the *matériel*, and the other five millions to the improvement of the telephone lines. When the five millions voted was proposed to the General Telephone Company it was refused. It told the State that its annual revenue, thanks to 6,500 subscribers in Paris, and the 2,500 in the departments, which it now possessed, reached a total of four millions; that, on the other hand, the proposed price only represented a third of the expenses of the installation of the telephonic *matériel*.

The General Telephone Company demanded the nomination of arbitrators: an expert to be named by the State, another by the company, who would be charged to estimate the amount of an equitable indemnity. In case of disagreement, a third expert, chosen by the first two, should be called in to give his opinion. This proposition was reasonable; it is enough to say it was not agreed to by the Administration of Posts and Telegraphs, who, on its side, proposed the arbitration of the Council of the Prefecture, and, in case of need, that of the Council of State. No arrangement being come to, the President of Council, Minister of Commerce and Industry, found it necessary to put his hand on the administration of telephones without further form; and by a warrant, dated August 23rd, enjoined the company to be ready to deliver its telephone lines, from the 1st of September, to the Administration of Posts and Telegraphs.

As will be seen, from the article of the contract cited above, that if the State had reserved to itself the right of purchasing the privileges resulting from the authorisation given and the *matériel* of the undertaking, it had completely omitted to mention the company's premises. So that when the agents of the Government present themselves this morning at the different agencies to take possession of the apparatus, the representatives of the Telephone Company, relying on the text of the concession, will be able to answer: "The *materiel* belongs to you under reserve of a price to be discussed; take it, but go and use it elsewhere. We are here in our own place; by installing yourselves in our offices in despite of us, you commit a violation of domicile foreseen and punishable by law." The Government will have nothing to answer; but they will instal themselves nevertheless in the Telephone Company's offices in contempt of every law. If, by these numerous violations of domicile, the State is condemned to pay heavy fines to the dispossessed company, what matters? It is the taxpayer who pays.

[*September 2nd.*]

The taking possession of the Parisian and departmental telephone lines is an accomplished fact since yesterday morning. We have said that the State was [illegible] a hurry to put its hands on this service, on the [illegible] elections, that it has not taken time to have [illegible] made of the *matériel* of the General Tele-[illegible] Company, still less of paying the price. Not [illegible] able to instal rapidly in its own premises the [illegible] which it purchased by virtue of the contract [illegible] already mentioned, the Government has thought [illegible] possession of the premises to which the sub-[illegible]' lines lead. The General Telephone Company, [illegible] was in possession of the premises in question, [illegible] to deliver them up; it only yielded to force. All passed off, however, in a very simple manner. At [illegible] 12 engineers or sub-engineers, designated by M. Cael, directing engineer of the district of Paris, and accompanied by a police commissary, presented themselves at the 12 Parisian telephonic offices. In each of these offices they were received by a manager or high official of the General Telephone Company, [illegible] by a sheriff's officer.

The Government hoped, by proceeding on a Sunday [illegible] various violations of domicile, to avoid the [illegible] reports of the Ministerial officers; but thanks to [illegible] of the President of the Tribunal of Com[illegible] the sheriff's officers required were authorised [illegible] yesterday (Sunday). These officers limited themselves, however, to verifying the facts; they could [illegible] draw up their reports till to-day.

In presenting himself before the delegates of the Telephone Company, the Police Commissary read the Ministerial warrant of August 30th, consecrating the seizing, and ordering the taking possession of the premises belonging to the Telephone Company. After this reading the Police Commissary informed the representatives of the company that he had received orders to place the engineer of the Administration of Posts and Telegraphs in office, and to warn the office *employés* that it was this new functionary they had henceforth to obey. It was M. Clément who arrived at the Avenue de l'Opéra agency. This gentleman, and the engineer who accompanied him, were received by M. Lair, chairman of the General Telephone Company, and by M. Berthon, assisted by a sheriff's officer.

"Do you give way before the Ministerial warrant I have read to you?" asked M. Clément of M. Lair.

"Not at all," answered the chairman of directors of the Telephone Company; "we shall only yield to force."

M. Clément hereupon informed M. Lair that the Ministerial warrant empowered him to use force. "In that case," said M. Lair, "I give way; but you will recognise in your report that I have only yielded to force; you will also tack on to this report the written protest which I hand you in, the name of the company."

The text of this protest is as follows:—

1. The company declares that it only yields to the injunctions made as constrained and forced, and under the most express reserve of its rights, means, and actions, as much on account of present facts as of all anterior facts on the subject of which protests have been made previously.

2. It protests against the present and effective seizure by the State of its working *matériel*, before comformably to the principles of common law and the stipulations in the agreement, the price of acquisition to which the company is entitled has been fixed and previously paid, and even before an agreement or even a definitive decision has been come to regulating the method of assessment and payment of the said price.

3. It demands an official certificate by which the Administration of Posts and Telegraphs has taken possession of the premises which the company occupies, in the absence of any consent or stipulation as to their cession to the profit of the State.

A very amusing incident marked the seizure of the telephone office in the Avenue de l'Opéra. The artist of an illustrated journal was sketching the scene in the office, when M. Clément went up to him, took his paper from him, and forbade him to sketch the scene. The seizure of the departmental offices was gone through with the same formalities and the same protests. No regrettable incident occurred.

The General Telephone Company looking after, before everything, the interests of its subscribers, had taken the necessary measures, so that the public service should not be interrupted. The Direction of Posts and Telegraphs promises large reductions in the price of the telephonic service, this is all right; but what will be wanting especially, in the period on which we are entering, is the discretion of the *employes* who have become functionaries. The secrecy of telephonic conversations is henceforth lost; we beg our friends not to forget it.

NOTES.

Bradford Electric Lighting Scheme.—The arrangements for the supply of electric light in Bradford are now practically complete, and it would be possible, we are informed, to lay on the current at once were it considered urgently necessary. It was stated that the engines had been thoroughly tested, and proved to be efficient for their work, and all the apparatus, with the exception of some internal fittings at the generating station in Bolton Road, was in a satisfactory condition. It will be necessary, however, to engage a staff of *employés*, and, inasmuch as the demand for the new lighting medium is not likely to be very great until the evenings lengthen, it was thought advisable to postpone the inauguration of the installation until about the middle of next month.

Electric Lighting at Bournemouth.—Last week the Brush Electrical Engineering Company, Limited, gave a brilliant display of the electric light in the fine square at Bournemouth, with the view of showing how effective this mode of illumination is for the exterior of hotels and public institutions. The company have established a plant and central station in the Gas Works Road, and provided on the present occasion five arc lamps of 2,000 C.P. each. Arrangements have now been perfected at Bournemouth, and the company propose to make an effort to introduce the light into Bournemouth on a sound and permanent basis. Newlyn's Royal Exeter Hotel and Highcliff Hotel will shortly be lighted by the company.

Electric Light in the House of Commons.—The London correspondent of the *Manchester Evening Mail* says: An opportunity will soon be afforded to contractors to light the Houses of Parliament by electricity. Up to the present time the authorities of the building themselves have had control of the small electric installation which exists, and has been completely successful in the hands of Mr. Prim, the resident engineer; but the Treasury seems to be unwilling to sanction the large expenditure necessary to light the whole of the palace. They therefore propose to call in the aid of some outside company, which will supply electricity at a fixed price per Board of Trade unit. No definite arrangements have as yet been made in this respect, and there is not likely, as far as can be seen at present, to be much competition for the contract.

Gas v. the Electric Light.—A good deal of stir has been occasioned at Bournemouth by the proposal to purchase the local gas works on behalf of the town. A town's meeting was held last week to consider the subject, when Dr. Clegg, who was one of the speakers, observed that the chief grounds of the opposition seemed to be the fear of the electric light diminishing the profit of gas. He had for some considerable time past studied the subject of electricity in all its branches, and had consulted some of the most eminent engineers, who concluded that the electric light must always be regarded as a light of luxury. He strongly supported the proposal. A resolution was eventually passed, by a large majority, in favour of purchasing the gasworks, but a poll was demanded.

The Lighting of Dublin.—On Monday, at the monthly meeting of the Municipal Council, Mr. Robinson, C.E., moved the adoption of the report recommending the borrowing of £50,000 to carry the electric lighting scheme into effect. After considerable discussion the motion was adopted by 35 votes to 3.

Telegraph and Telephone in Uruguay.—A Manchester paper says :—The telegraph communication of the country is ample for present needs, and places Uruguay, through the capital, with all the countries of the world. In Monte Video there are two telephonic companies in active operation, and, though there are only 150,000 inhabitants, the average of the daily communications number 6,000. The telephonic subscribers in the city are 2,226, the proportion being 159 subscribers to every 10,000 inhabitants ; whereas in Berlin it is only 48 ; in Paris, 21 ; and in Buenos Ayres, 65. Monte Video has more than double the number of telephones that Madrid has with 398,000 inhabitants, more than three times the number that Lyons possesses with 402,000 inhabitants, and almost six times as many as Marseilles.

Electric Lighting in Stockholm.—The electric light is steadily gaining ground. The greater part of the Royal Palace is partly lighted. Messrs. Leith and Rosen have fitted up the new market *halles* with 353 glow and 14 arc lamps, the former of 10—16, and the latter of 800 candle-power each. They are worked by two compound Schuckert dynamos. The plant is guaranteed for two years, and the lamps for 180 hours ; the total cost for the installation is £1,800. There is every possibility of a central station being soon established, and the gas board have urged upon the municipality the necessity for this step. This was suggested as far back as 1886, but not carried out on the grounds that any work at that period would soon become obsolete.

The Tabor Steam Engine Indicator.—[Abel Heywood and Son, Manchester, and Simpkin and Marshall, London, 1889.] This little work emanates from the firm of John Musgrave and Sons, Limited, of the Globe Iron Works, Bolton. It is bound up conveniently with a pocket to contain loose diagrams. Besides setting forth the description of, and the advantages pertaining to, the Tabor indicator, with instructions for its management, a chapter devoted to calorimeter testing is accompanied with a diagram and full particulars of a simple form of apparatus for making these tests ; 34 useful tables are also appended. The firm have in addition endeavoured to supply a want by the production of a revolution counter which they are willing to supply for the small sum of 4s. 6d.

Electricity on Ships.—During the past month several large ships have been lighted by electricity. Among these may be mentioned the Inman Liner *City of Paris*, a large screw steamer, built by Messrs. Scott & Co., Greenock, for the Mala Real Portuguesa and many others. It is also intended to fit the electric light plant on three Admiralty cruisers which are being built by the London and Glasgow Shipbuilding and Engineering Company, Limited. Several Clyde shipbuilders are introducing electrical departments in their yards, and will thereby be enabled to undertake contracts for ship lighting.

The Swedish Government and Electricity.—The Government some time ago despatched Lieut. L. A. Aufelt to the Paris Exhibition, in order to study the most recent development of electrical science, particularly as regards lighting, motive power, and submarine mines. He has now proceeded to Germany for the same object.

Count Edison.—*Modern Light and Heat* (Boston) says Mr. Edison has been made an Italian Count, which honour carries with it the title of Countess for Mrs. Edison.

Water Power.—At a meeting of the Norwich
Council last week the question was asked w
fall of water could not be utilised for the s
electricity. It is to be hoped the Council w
neglect this opportunity, if practicable, of util
advantageous a power.

Bottone on the Electrician's Slide Rule.—W
produce the following letter of S. Bottone to the
of the *English Mechanic*, which has reference
Fleming's slide rule, which we noticed in a le
three weeks ago :—I sent you, sir, for public
the *English Mechanic* (see p. 472, Vol. XLVI
description and illustration of an electrician's
rule, designed by John Innes, F.C.S., Llanelly,
aid of which all questions connected with volts,
power, and watts on the one hand, and incand
candle-power, ampères, metal deposited per ho
on the other, could be immediately read off.
illustration of this rule was so good as to enable
to construct such a rule had he been so incli
have just received from the Edison and Swan
Light Company a circular dated August, 1889,
a slide rule, differing in no essential respects f
above, is described and figured, and attributed
J. A. Fleming. As even the mode of using the
is given in words which are almost the *ipsissima*
used by Mr. John Innes, I am surprised that
the Swan-Edison Company, nor yet Dr. Fleming,
have acknowledged the source from which the
this slide rule was originally derived. While o
subject I may point out that the Woodhous
Rawson Company are selling (see *Electrical Pl*
No. 26), and Messrs. King, Mendham and C
have actually *patented*, a "watch" form of
galvanometer that I have been making and selli
the last four years ; the only difference is that
strument indicates, besides volts and ampères,
direction of current and the N. and S. poles, all
being marked on the dial.

**The Swiss-German Rhine Canal Company, Bi
den (Basle).**—A correspondent writes :—"The F
Committee of the above-named company has
published the prospectus (on which I recently
a report), see ELECTRICAL REVIEW, August 30th,
which the public is invited to subscribe for shar
the undertaking. But this new edition of the prosp
shows, by small modifications scarcely noticed at
first glance, a sense of the peculiar circumstan
which I have informed you. In the first place, the
of places where subscriptions may be paid is red
from 25 firms (19 German and 6 Swiss) to 16,
besides the firms mentioned in my former commu
tion, which have publicly denied their connection
the undertaking, six further firms (three German
three Swiss) have been omitted in the list. Fur
the statement that considerable sums have been depo
with the Commercial Bank of Basle as a guarantee,
been omitted in the modified prospectus. On the o
hand, the firm Thomson-Houston figures in the rev
prospectus with the name Housten. As regards
ominous guarantee deposit, the projectors publis
Swiss newspapers a very peculiar explanation.
bank, Kidder, Peabody & Co., of Boston—so they
us—has handed over to Baring Bros., of London,
guarantee deposit of 50,000 dollars, in order to tra
it to a Swiss bank in the interest of the company.
is the substance of the somewhat confused explana
In opposition to the statement of the three banks w
(as explained in my former letter) had been introd
in the prospectus against their will, it is now
by the promoters that the three firms had offer
receive subscriptions, and had stipulated for the
sive agency in extensive districts. Messrs. Bell &
of Kriens, who have also been named in the pros
of the above society—as furnishers of the turbin
the proposed plant — are now protesting
Allegemeine Schweitzer Zeitung against their firm
named in combination with the said enterprise."

A New Dynamo.—A new dynamo is used for the lighting of the *Geelong Times* office, Melbourne. It is the invention of Mr. Alcock, of the firm of Messrs. A. W. Alcock and Co. of that city, and he intends applying for a patent. We have not yet particulars to hand.

Profit in Motor Work.—The following appears in a recent edition of the New York *Electrical World* :—The question, "What profit is derived from selling current for operating electric motors ?" was recently put to the superintendent of a well-known electric light and power station furnishing current to about 125 H.P. in small motors. His answer was, 38 per cent. net profit on the original investment. Part of his daily expense account for operating the motors only is made up as follows : Coal, $9 ; water, $1.20 ; waste and oil, 10 cents ; sundries, $3 ; labour, two men, $4. It is evident that the profit lies largely in the fact that the motors are numerous and small. The same quantity of current supplied to, say, four large motors of 30 H.P. each, would not yield any such return. But even then there would be a much better margin than is suspected by those who have not yet looked into motor problems, or noted how remarkably the varying call for current practically doubles the capacity of the plant for motive power purposes.

Belfast Telegraphists.—In the House of Commons on Tuesday, in answer to Mr. Sexton, Sir H. Maxwell said : During the past 15 months no resignations have occurred in the first class of telegraphists at Belfast. Five resignations occurred in the second class. The Postmaster-General received some time ago a memorial from the telegraphists asking him to create a number of first class appointments in order to give them promotion. This memorial he carefully considered, and came to the conclusion that there were no duties to be performed that would justify additional superior appointments at that time, and he caused a reply in this sense to be sent to the memorialists. The question will shortly come again under his consideration, when he will see if there is any change in the circumstances. Mr. Sexton asked the Postmaster-General whether a vacancy in the Belfast Telegraph Office in the first class had been filled by the appointment of a gentleman who had for years held, and still holds, the position of telegraphic instructor in the Midland division of Ireland ; whether this official had been absent from the Belfast office some eight years ; and whether, during this period, he was connected with the Surveyor's Office in Dublin, and under the immediate control of the authorities there ; and if so, whether it was in accordance with usage to appoint to a first class post in the Belfast office an official who continued to perform a specific duty in another section ; and whether, in view of the stagnation of promotion existing in Belfast, this appointment would be made redundant. Sir H. Maxwell : I have to say in reply to the hon. member that the facts, so far as they are stated in his question, are substantially correct. It should, however, be added that the inspecting telegraphist referred to is a member of the Belfast staff, and was the senior officer on his class qualified for promotion. The question of making an additional first class appointment, which would in effect give a promotion, is under the consideration of the Postmaster-General.

Books Received.—"The Alternate Current Transformer in Theory and Practice," by Dr. J. A. Fleming, M.A. *Electrician*, London.

"A B C of Electricity," by Wm. H. Meadowcroft, endorsed by T. A. Edison. John Heywood, Manchester and London.

"University College, Bristol, Calendar for the Session 1889-90," Arrowsmith, Bristol.

John A. Roebling, Sons & Co., Trenton, N.J. : List of bare and insulated wires. This latter is a neat little booklet, in which the various wires are admirably set forth, and wlll probably be of great assistance to the profession.

An Effect of the Copper Syndicate.—The report of the Barmen Chamber of Commerce affords an illustration of the widespread character of the evil done to trade by the notorious French copper "ring." The manufacture of brass eyelets is an industry of some importance at Barmen. The great advance in prices which the manufacturers were compelled to make to cover the additional cost of the raw material drove away a large proportion of the trade to Paris, where the makers of eyelets were favoured by the syndicate. This loss of trade, which has been keenly felt, is not likely to be soon recovered.—*Industries.*

The Circular of the Institution of Electrical Engineers.—In our correspondence columns we publish further letters on this subject—one from Mr. Webb, secretary of the Institution, explaining how the mistake arose.

Manchester Technical School. — We hear that Messrs. Mather and Platt have promised to give to the school a 100-light dynamo, for the use of the electrical engineering classes of the school.

China Telegraphs. — The correspondent of the *Standard*, telegraphing from Shanghai on Wednesday night, says :—The Viceroy Li Sheng, Paotai, has nearly completed the preparations for the construction of a telegraph line from Pau Ting Foo, near Peking, through Shansi, to connect with the Russian telegraphic system at the frontier town of Kiachta, in Siberia. When carried out, this new means of communication cannot fail appreciably to reduce the cost of telegrams between China and Europe.

Destruction by Lightning.—Early on Wednesday morning four farms and premises, situated at Rayne, Sampford, Waltham, and Dunmow, were burned to the ground with all the live stock on them. A house of Mrs. Walford, at Seal Chart, about two miles from Sevenoaks, was struck by lightning, and the dwelling completely gutted. The lightning entered the servants' bedroom, which was soon ablaze, and the inmates had a narrow escape. Several sheep at Sutton Vallence were killed by the lightning, and a bullock was killed near Maidstone. Messrs. Evans's silk-printing mills at Crayford were set on fire by lightning, and over £10,000 damage was done.

University College, Liverpool.—A prospectus has been sent to us of the day classes in Arts and Science, and of the evening lectures for the approaching session. It is announced that the Professor of Experimental Physics, Dr. Oliver Lodge, intends delivering a course of lectures on the Functions of the Ether, or Recent Progress in Electricity, in which he will treat of the subjects which are exciting so much attention at the present time, and the unusually interesting discoveries which are being rapidly made, the hope being expressed that contemporaneous discovery may be introduced as the lectures proceed.

The Electric Railway on Ryde Pier.—This railway has turned out a decided success, and it has been found that one line of rails is totally inadequate for the fast increasing traffic. It is the company's intention to lay down a second line to meet this want, and also to effect other extensive improvements on the pier.

Important Sales.—Messrs. Wheatley Kirk and Co. announce for sale, on the 24th, some first-class engines, machine tools, and other effects, at the yard adjoining St. George's Church, St. George's Circus, Borough Road. Further details will be found in an advertisement. The contents of Mr. Oppermann's electrical works, at Amhurst Road, Hackney, are also to be disposed of in the same way on September 18th. We understand that the electrical bell and signal business of Messrs. Jensen and Co. has been disposed of by the same firm in one lot as a going concern.

Completion of the Stockholm Cable.—The great telephonic cable between Stockholm and Gothenburg has at last been completed, having been some nine months in construction, so that the whole of the south and central part of Sweden and a considerable portion of the north are thus connected. The Crown will maintain stations in all towns touched by this telephonic artery.

Machine Driving by Electricity.—The expectation which electrical engineers entertain that a great movement is about to take place in the direction of an extensive use of electro-motors, has induced the United Electrical Engineering Company to prepare for publication a descriptive illustrated pamphlet for the information of prospective users. Being addressed to those who desire to cheapen and simplify manufacturing, or other processes in which power is employed, it deals concisely with the main principles involved, and refers to some of the numerous useful purposes to which the electro-motor is applied. Prominence is given to the special types of apparatus supplied by the company; but a considerable amount of general information is given also, rendering the publication well worth perusal by everyone interested in the subject.

Hyde Park Electric Works, Glasgow.—New premises are being built at this address for Messrs. Anderson, Campbell & Munro. The works are being fitted up specially for the business, and it is intended by the firm to manufacture their own machines, &c., arc lighting and transmission of power being specially attended to.

The Year Book of Commerce.—This volume of 292 pages, which is compiled under the authority of the London Chamber of Commerce, and published by Cassell & Co., is a development of the statistical section which for the last six years has formed part of the annual report presented to the Chamber. The council considered that these statistics, thus amplified and made more general, would prove worthy of a special and separate publication. The year book will no doubt supply a convenient handbook of statistics for commercial purposes, especially as the information given is made up to dates far in advance of that available in any other single publication.

Electricity and Railways.—The following letter has been sent to the *Newcastle Daily Journal*:—"There is a proposition I should like to place before the meteorological section of the approaching meeting of the British Association. It opens out a problem which I have never seen mooted at any time, yet I conceive it to be of considerable importance, and well worth discussion by *savants* who have studied the subject of electricity. What I wish to submit for consideration is, 'In what manner will the electricity in both earth and air be effected by the long lines of iron railways (first-rate conductors) which run north and south, also ramify in all directions over our island.' I cannot for a moment suppose that this wide spread network of iron cannot to a very great and appreciable degree influence the distribution of electricity, either equalise it throughout or cause a dangerous accumulation of electric fluid at some point where the atmosphere is in an abnormally excited state, causing a flow of electricity to this already overcharged centre, having a deleterious effect on the climate. I do not presume to give an opinion, but merely throw out the suggestion, hoping that some one more competent to deal with the subject may take it up." This idea is by no means a new one, the subject has been referred to more than once, and many years ago. We remember having seen it stated that the introduction of the iron road across the arid prairies of America has greatly modified their climatic conditions.

Okonite.—With reference to a remark occurring in our leading article last week, the English representatives of the Okonite Company point out that the okonite insulation has stood the test of 20° F. below and 250° F. above zero, repeated many times on the same wire without deterioration.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Electric Propulsion and Traction Company, Limited (formerly the International Engineering Company, Limited).—An agreement of 16th ult., filed on the 26th, cites that by an agreement of 15th [illegible] company agreed to purchase for £1,884, in fully-paid shares, certain property mentioned therein. This present agreement confirms the previous document. The registered office of the company is situate at 50, [illegible] Street, E.C.

African Direct Telegraph Company, Limited.—The annual return of this company, made up to July [illegible] was filed on the 1st ult. The nominal capital is [illegible] in £10 shares. 23,600 shares are taken up, and the full amount has been called and paid thereon.

Hermite British Electro-Bleaching Company, Limited.—The annual return of this company, made up to July 8th, was filed on July 9th. The nominal capital is £50,000, divided into 1,500 A shares of £30 each, and 1,000 B shares of £5 each. 1,000 A shares and 1,[illegible] B shares are allotted, the former being considered fully paid, and the full amount has been paid upon the latter.

J. G. Statter and Company, Limited (electricians).—At an extraordinary meeting of the members of the company, held at the Alliance Works, West Drayton, on the 29th June, the following resolutions were passed, and at a meeting held at the same place, on the 27th July, they were confirmed, and were duly registered 10th ult., viz.: 1. "That the capital of the company be increased by the creation of 1,000 new shares of £10 each, to be issued on such terms and conditions as the directors may determine." 2. "That the directors be empowered to add to their number, and to their remuneration, to provide for the proposed new directors." The nominal capital is now £30,000 in £10 shares.

Kay Brothers, Limited (manufacturers of electrical, chemical, surgical, and scientific apparatus).—The annual return of this company, made up to the [illegible] May, was filed 1st June. The nominal capital is £100,000, divided into 9,990 ordinary shares of £10 each, and 100 founders' shares of £1 each. The shares taken up are 7,120 ordinary and 100 founders. Upon the former £71,300 is considered as paid. Registered office, St. Peter's Gate, Stockport, Cheshire.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts for the month of August were £2,700 as compared with £2,[illegible] in the corresponding month of last year. The receipts for the month of May, estimated at £3,560, realised £3,513.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of August were £1,634, against £1,643 in the corresponding period of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of August, 1889, amounted to £39,460, as against £[illegible] in the corresponding month of 1888.

The Eastern Telegraph Company, Limited. The receipts for the month of August, 1889, amounted to £52,012, against £43,703 for the corresponding month of last year.

The Great Northern Telegraph Company, Limited. The receipts in August, [illegible] £24,000; January 1st to August 31st, 1889, £178,300; corresponding months [illegible] £179,300; and of 1887, £174,130.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the week ending 30th August, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,663.

The West Coast of America Telegraph Company, Limited. The gross receipts for the month of August were £4,356.

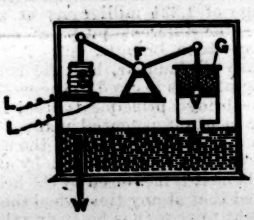
The West India and Panama Telegraph Company, Limited. The [illegible] receipts for the half-month ended the 31st August are £2,118, as [illegible] with £2,530 in the corresponding period of 1888. The May receipts, [illegible] at £6,219, realised £6,203.

DYNAMO ROOM ACCESSORIES FOR INTENSITY, POTENTIAL, AND RESISTANCE MEASUREMENTS.*

By C. C. HASKINS.

The investigator who expects to find a steam plant running without a water and a steam gauge at the present day will reckon without his host, and in very many instances he will find also a tell-tale pressure gauge in the office of the manager, who can turn at any moment, without moving from his desk, and see as well as if he took a run over to the engine room, what pressure the boiler is carrying. It was not so in the days of Boulton and Watt, but the fact that those worthy representatives of the past were without such modern appliances has not kept these from becoming honoured occupants of the engine room of to-day. Progress is near akin to that mother of invention of whom we so often hear, and progress just now calls for more and better appliances for the improvements of our methods of producing and the handling of that boundless and wonderful energy which we call electricity. We have advanced far enough to see that economy in production is essential, and we are now learning that having once developed that energy, the old and homely adage of Franklin, "Waste not, want not," is as applicable to electric economy as to matters of merchandising or the cultivation of the soil.

While the inventor is striving, and with reasonable success, too, to lessen the fuel expense, and the wear and tear is being looked after by the constructor, we may ask, Is the operator keeping his end of the burden level by a proper attention to the means within his reach for aiding in the general economy? That the inventor has assiduously laboured at his part of the task is abundantly shown by the records. There are meters and meters. Ingenious meters, and almost judicious meters. No sooner was it seen that a necessity had arisen for something by which to measure currents, than men of inventive ability and men without, nearly tumbled over each other in their haste to reach the front, and present their various claims. A look at a few of these may not be uninteresting. I have not endeavoured to classify the following, nor do I claim to have gathered all there are in existence. To many of these there are several claimants, and I have quite generally adopted the rule of mentioning no names, a safe method, perhaps, of keeping out of the muddle which sometimes arises from a trifle of jealousy, and leaving the ownership to be decided by others. My object is to cite the apparatus, not the inventor.



S, Solenoid; F, centre of motion; G, water inlet; V, valve; W, overflow; L, L, line wire.

FIG. 1.

Gravier, in 1880, suggested that with a given carbon, the current consumed would bear a direct ratio to the amount of light given. He supported his statement by mathematical calculations and comparative tests by other methods. This was ampère measuring by photometry. In the same year Marcel Deprez and Siemens and Halske brought out nearly parallel inventions. In the former, a long coil is placed parallel to, and between the legs of a horizontal horseshoe magnet, extending from the neutral point to the poles. This coil is so adjusted as to revolve, like a shaft at right angles to its length, being delicately supported at either end. An index attached to the shaft is made to act as a scale beam, and a sliding weight restores it to zero. This form of galvanometric weighing differed principally from Siemens and Halke's invention in that the latter was a vertical arrangement of coil and magnet. Becquerel and Joule had also accomplished much the same result before them. Hopkinson's voltmeter had two parallel wires, through one of which the current was passed. To one of these an index was attached, the other being part of a graduated arc. The dilatation of the wires by normal heat moving both index and scale in the same direction kept the indicator at zero, so that when a current traversed the second wire there was no error due to normal temperature to be corrected. Heat in this case was the measure of pressure. Siemens and Halske, among other inventions, exhibited one of a still different form. In this, there is a combination of solenoids and clockwork, with a registering disc.

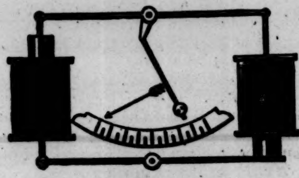


FIG. 2.

A very radical departure was made by an English inventor, who is well known in electric lighting. In the system which he patented, a lever at one extremity terminated in a solenoid core, while at the other extremity of the lever was a plunger valve. When the current passed through the coils of the solenoid, the core was sucked in, the valve was opened, and water flowed out more or less rapidly in proportion to the size of the opening, which at last, of course, was governed by the suck of the solenoid, a sort of temperance ampère-meter. An automatic syphon emptied the reservoir and then it filled. The quantity of water was assumed to be directly proportioned to the flow of current. See fig. 1. In Blythe's ampère-meter, a vertical solenoid has an adjustable core suspended from a spiral spring. A vernier gives the direct reading of from one-tenth of one ampère to 100 ampères.

The Deprez-Carpentier ampère meter came to the front about this time in the succession. It contains two permanent magnets, bent half way round the inner circumference of a circular box. When nearly at the quarter of each side, the ends are bent inward, parallel with the diameter, and extend parallel with it until they nearly touch. Now we have two magnets, each not wholly unlike the capital letter C, with the open portions facing each other in the middle of the box. In the space left by the magnets, where the four poles so nearly join, is an electro-magnetic coil, which carries the needle and is actuated by the current traversing it. This was a bold step in advance. Kapp modified the Deprez-Carpentier instrument by making the magnets electro-magnetic, instead of permanent. The scale was graduated experimentally, and the instrument was formed for an ammeter or voltmeter, according to the size of wire used. Here was quite a radical departure. Uppenborn developed a novel idea in the use of an eccentrically shaped armature lying on a simple electro-magnet core, and a pointer fixed to the same axis as the armature. The pointer stands at one end of the curved scale when at zero. As the current increases, the eccentric face of the rolling armature gives to the pointer a movement along the scale, and a direct reading may be had. This graduation is arbitrary—done by a sort of cut and try method, or thumb rule. The improved voltmeter of this form has two coils instead of one, the greater to extend its sphere of usefulness. A switch gives choice of the coils.

There are forms in which the needle is loaded with small magnets, and the poles of electro-magnets are so placed as to double the magnetic action of these on the balanced needle. The molecular structure of glass is so affected by the magnetism as to change the direction of a beam of light transmitted through it, and this property has been taken advantage of to measure currents of electricity by the deflection of a ray of light. In one of that form of voltmeter which measures current by the expansion of a wire through the heat generated by the passage of a current, some improvement has been made. In this a wire of platinum silver is enclosed in a brass tube held in tension by springs or weights. Formerly the absolute tension of the wire did not give exact results if the wire was exposed to changes of atmospheric temperature. Even when not in use the zero of the instrument is changeable. In the more recent instrument the brass tube surrounding the wire is made to have the same coefficient of dilatation as the wire itself, so that by compensation the zero remains very nearly absolute. The outer air has no longer any power to change and falsify the record of the instrument. Another form of voltmeter in which the dilatation of a wire is utilised to measure current pressure is a modification of the last. There were unforeseen difficulties in the way of accuracy. The increased length of the wire was assumed to be solely due to heat expansion, but investigation showed that with that expansion there must be considered the change in stress consequent upon the elongation, and the accompanying increased sag. A remedy very similar to the former remedy was applied, and the work is now sufficiently correct for all practical purposes.

A French invention is dependent for its results upon the action of solenoid attraction upon a movable core, the depth of this plunge being compensated by a weight which slides on a steel yard arm attached to the pointer—a method of weighing the current. Deprez, according to Niaudet, conceived the idea of valuing current by weighing it by the aid of a solenoid coil. The scale of proportions was arrived at by actual experiment. A certain known current balanced a given weight. A second current would balance a greater or less weight, according to its quantity, and thus he was enabled to say "with a magnet of such and such proportions I find that a current which weighs blank grammes is a current of 10 ampères."

A well-known inventor has endeavoured to utilise the heat generated by a current to turn a horizontal wheel, against the diagonal paddles of which the rising air impinges. In another form there are two upright solenoids and two cores. These cores are fixed to, and are a part of, a rectangular frame which moves on two centres at the middle of the top and bottom bars of the frame. At two diagonally opposite corners the cores are placed, and the winding of the coils is such that when one core is sucked up into one coil, the other is drawn downward into the other coil. This see-saw motion is communicated to the pointer from its being fastened to the frame at the upper centre of motion. A counter-weight tends to hold the pointer at zero when in a state of rest See fig. 2.

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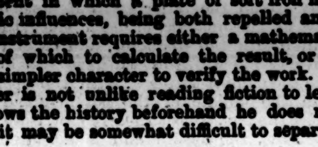
*Paper read before the National Electric Light Association, Niagara Falls, 1889.

Measurement of the gases developed by the electrolysis of acidulated water was one of the first as well as simplest of apparatus. Secondarily, the heat so generated has been made to do duty as a meter. An ingenious German inventor endeavoured to utilise the heating effect of current by the aid of a double thermometer, the two branches connected with a thermopile in a way to increase the temperature in one branch and reduce it in the other, through the Peltier effect, when current is sent through the thermopile. Walker, in 1885, and Wolf, 1886, also utilised the electrolysis of acidulated water with platinum electrodes. A Russian electrician measured the time necessary for the evolution of one cubic centimetre of hydrogen by a given number of ampères of current. From this as a starting point he has formed a table showing the time necessary to disengage one unit of gas with one unit of current at temperatures varying from 15° to 24° centigrade.

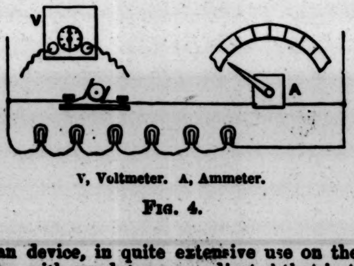
A German was among the first to discard springs and permanent magnets in ampère-meters and voltmeters. His instruments were galvanometers, with regulating pieces of soft iron for adjusting the index pointer. An English firm followed about the same time with a novel idea in ammeters, in which the compound action of magnet upon magnet was utilised. To escape the use of springs and permanent magnets, a French inventor produced an instrument in which a plate of soft iron is affected by opposing magnetic influences, being both repelled and attracted. The use of this instrument requires either a mathematical education, by means of which to calculate the result, or some other instrument of a simpler character to verify the work. The use of this form of meter is not unlike reading fiction to learn history. If the reader knows the history beforehand he does not need the fiction. If not, it may be somewhat difficult to separate the true from the false.



C, centre of motion; M, mercury cups; R, coils.

FIG. 3.

Simplicity is made simpler in another form, where the inventor uses an electro-magnet with a multiplicity of armatures, each held back by its own retaining spring. The more current you use for bait the more armatures you will catch. All you need to do is to count them. A novel form had its origin in Berlin. In this the pivot of the index needle lies within the solenoid, and one or more short fine wires are attached to this centre, at about right angles to the needle. The magnetic action tends to set these, which are, in fact, one armature, at right angles to the current, and as a consequence, the indicator is moved along the scale. The weak point in this and many other clever instruments lies in the fact that magnetic action is not proportional to the angle of deflection, but to the tangent of that angle. An Austrian inventor places the needle between two contact screws, and any deviation from normal voltage closes the circuit through one or the other of the two coils, having differently toned bells, so that the *employés* are warned not only that the pressure is changed from normal, but whether it is above or below that point.



V, Voltmeter. A, Ammeter.

FIG. 4.

A European device, in quite extensive use on the Continent, has two clocks, with pendulums so adjusted that in their normal condition their motions are perfectly synchronous, though independent of each other. One of these pendulums terminates in a fork, which holds a spool of fine wire, and this last is free and swings back and forth in a coil of coarser wire, like a core in a solenoid coil. The main current energises the larger or stationary coil, while the movable coil of fine wire is in a derived circuit from the main line. The mutual action of the magnetism in the two coils, of course, varies the pendulum motion, and a set of clock-face counters—similar to those on a gas meter—registers the amount of current.

The heat developed by resistance offered to the passage of a current has been utilised to vaporise a liquid and produce motion in an ingenious manner. A horizontal lever has dependent from either extremity a closed bulb, containing a fluid. The two bulbs are connected, and in their normal condition are balanced. Within the fluid a coil is placed, its terminals extending down through the bottom. When either bulb is depressed these terminals [illegible] mercury cups and complete the circuit. Heat is generated in the coil, the liquid is vaporised, and the vapour makes its way over to the other bulb, where it is condensed. By and bye the balance is destroyed and the beam tips, breaking the circuit on one side and making contact on the other. The operation is repeated alternately from either direction, and every time it makes one complete vibration a ratchet wheel is pushed one notch ahead by a [illegible] attached to the tilting lever. See fig. 3. To obtain a permanent record of the meter's work, a well-known French maker of instruments of precision added a revolving drum of paper, on which a pencil attached to the index lever traces the variations of voltage.

A very clever method of getting the pressure of a high voltage system by means of a low voltage instrument has been used with fair success by the aid of high resistance incandescent lamps. A sufficient number of these, arranged in series, are placed in a derived circuit around the motor, dynamo, or lamps. When the proper number of these is introduced in the circuit to bring the candle power up to proper brilliancy, the lamp resistances are measured separately, and the aggregate is comparatively the difference of potential between the terminals—a good approximation in a system where no better can be obtained. See fig. 4.

Of electrolytic meters there have been many. One of [illegible] construction is an American invention. In this apparatus the entire line current is passed through a solution of caustic potash. The gas evolved, after being forced through water to clear it of froth or other impurities, passes into a meter similar to that used for gas measurement, whence, after having moved the dial, it is permitted to escape into the open air.

In this class of meters there are probably none better known than those in use by the Edison system throughout this country and Europe. Their action is based on the electro-chemical deposit of zinc, an average of 1,224 milligrams of zinc per hour per ampère. Of these, for different purposes connected with that system, several have been brought out. A very ingenious one, with which you are all familiar, has the lamp attachment, by which a safe temperature is insured to the meter.

The Wheatstone bridge principle is used in one form of pressure indicator for constant potential plants. The circuit to be measured includes a lamp through which the current flows. The amount of current passing is determined by its voltage, and the resistance of the filament is measured by the heat developed. The scale is so graduated that at any time when the needle of the galvanometer is brought to zero, thus balancing the bridge, the index pointer gives a direct reading of the current pressure. Another modification of the bridge principle is used for constant potential current measurements. In this form one or two standard cells are placed in derived circuit around a variable resistance. The battery is opposed to the current under examination. When, by sliding the contact along the scale the needle is brought to zero, the pointer indicates the voltage sought.

When the question is of meters for alternating currents, the problem is much more complicated, but the inventors, nothing daunted, have, since the comparatively recent introduction of these systems, done an immense amount of attempting with some success. Many of these are of such recent birth that patents have not yet been secured, and inventors are somewhat reticent about having their little ones paraded before the electrical public too early, for reasons of their own. Siemens's electro-dynamometer was one of the earliest instruments for measuring the potential of an alternate current. In this the inventor availed himself of the mutual reaction between two coils, one within the other. The inner coil is connected to the circuit on one side through the torsion spring which holds it in suspension, while the other terminal rests in a mercury contact. This arrangement permits of a rotary motion without breaking the connection. The deflected coil is brought back to zero until it will no longer deflect. The pointer gives a reading which is proportional to the square of the current. It will be readily seen that no matter how often or how slowly the alternations take place, the result must be the same, for no sooner does the direction change in one coil than the other is similarly affected. Another form of induction instrument is described in a German technical journal. In this there are no less than four coils, two main and two secondary. A Wheatstone bridge figures in the combination, and plays an important part in the apparatus, which is too complicated in its detail for any but an extensively illustrated explanation.

As early as 1884, the current itself was made to do duty in energising an electro-magnet, as up to that date permanent magnets were unsatisfactory; but Weston's new instrument, in which a permanent magnet is used, I have seen tested with very rough usage without perceptible change. The method of magnetisation, I believe, is known only to the manufacturers.

Objection has been made to the use of springs in measuring instruments, because of an assumed liability to change in form or elasticity. This assumption seems to me fallacious when we consider the reliability of delicate mechanism like time-keeping machinery, in which a spring not only furnishes the motive power, but a spring as delicate almost as it is possible to make, is the regulator as well, and when we remember the permanent molecular changes which might be expected to arise from the rapid doing and undoing of the delicate hair-spring, or the heavy and powerful daily movement of the driving spring.

Many more systems might be mentioned. Indeed, one hardly knows where to stop, for every weekly report from Washington adds to the list of instruments for the measurement of either pressure, or quantity of work, or something. Many that I have mentioned are out of place, save in the laboratory, while as to the correctness of the results obtained electrical doctors disagree to an alarming extent. As a result, the majority of ampère-meters in industrial use are to-day known as ammeters, and for simplicity of structure are little more than a stick and a string—a hollow coil, which is the arc of a circle, the centre of which is the centre of motion of a radial arm terminating in a wire core, with an index arm attached, which in a state of rest stands at zero. A solenoid, with a direct reading scale—that is all. If correct, it is all that is necessary—but who knows? Of the more complicated apparatus, much may be said as to its accuracy of action. Those in which permanent magnetism is used have not hitherto retained the magnetism constant, and it is a mooted point between certain French and English electricians whether there is any method by which an accurate measurement of an alternate current can be made by any known process. In a discussion of this nature I can see perfectly well a little way back, and do not purpose venturing an opinion. The change in the magnetic power of a horseshoe magnet has sometimes been attributed to the careless method of removing and replacing the armature. Prof. Hughes has suggested that the only constant magnet is one which, after thorough saturation, is hammered until every possible trace of its magnetism is driven out of it. The small residuum is permanent, and not likely to change. Dr. Hopkinson, with other lesser lights, has repeatedly found that the employment of an astatic needle is imperative in the neighbourhood of magnets and magnetic fields. The use of an iron casing does not thoroughly obviate the difficulty. The necessity for a constant is a serious drawback to the ordinary user, even should the calibration of the instrument remain unchanged. The use of battery by which to energise an electro-magnet introduces another serious inconvenience. A standard battery is not at all times readily attainable—is not inexpense, and may possibly be unreliable.

In galvanometer work with a portable battery of standard cells, I have noted a marked difference in deflection through standard resistances, which I could not explain. The importance of convenient and constant, as well as simple apparatus for the measurement of current flow, as well as potential, is of easy comprehension. It may be summed up in a single sentence, which might appropriately be framed and hung in the dynamo room, as a hint to the engineer and the dynamo tender. "It takes money to buy coal." Excess of pressure in a constant potential system means, as an electric light man once tersely remarked to me, "coal wasted, filaments busted, patrons disgusted." There is always a triangular duel between the patron, the company and the coal pile on the subject of ampères, volts, candles and lamps and dollars. Now and again the wire men, too, are drawn into a wrangle on the subject of insulation, or the armature conplains in a very feeling way that it has been absued needlessly. Thus, from every standpoint, the necessity of keeping a safeguard over undue waste is a vital question with the electric light men.

Hand in hand with apparatus for measuring current flow and current pressures should go instruments of precision for the daily measurement of line insulation and copper resistance. I use the phrase "instruments of precision" advisedly, as the only known apparatus in many localities, and in far too many stations, is as distant from being an instrument of precision as a bellhanger is from an electric wireman. As you are probably aware, this conviction is not a recent one with me. If there is any one thing in the whole business of electric lighting for which I have the most thorough and uncompromising dislike for testing circuits, it is the magneto bell. I wish I could feel that all my hearers were in full sympathy with this sentiment. The objections to the ordinary magneto are many and positive. In the first place, it is an alternate current generator, and will ring on a perfectly insulated line of sufficient static capacity, as readily as with a dead ground. There is positively no way of determining how much insulation resistance there is in the line. It will ring or it will not, and that is all you ever know. There is no degree of measurement. With one person who grinds it there will be a ring, while a less vigorous *employé* will fail to make any impression upon it. It becomes in the hands of linemen who are encouraged to use it a scapegoat for neglect, for laziness and a loss to the owner of the plant. It has not the range required for proper insulation of an arc line, nor even for a 50-light incandescent plant. The range of the ordinary magneto is less than 15,000 ohms.

With a tangent galvanometer, the measurements may be made by a little exercise of pencil and paper, and the aid of a table of tangents. The intensity of the current, as measured by the tangent galvanometer, is proportional to the tangent of the angle of deflection of the needle. We will first obtain a constant by the measurement of a known resistance—say, 10,000 ohms. Any other known resistance would be as well. We note the deflection, and turning to a table of tangents, note the tangent of 30 degrees. We next connect one pole of our battery to earth, and the other terminal to the galvanometer, which latter is connected to the earth. All detectors and other earth attachments having been removed, the whole is now a metallic circuit. Closing the key, we note the deflection in degrees of our line insulation, and find the tangent of that figure in the table.

Now, the tangent of the first deflection, multiplied by the known resistance, 10,000, and divided by the tangent of the second deflection, will give us the number of ohms of line insulation resistance. Or, its tangent is to the deflection through the known resistance as the tangent of the second deflection inversely is to the unknown resistance. A very convenient little combination has been much used in Chicago, which answers an excellent purpose in construction work and testing, where all that is necessary is to reach a maximum insulation. In a small box, a battery is placed with a switch for connecting with a galvanometer through a standard resistance coil, or to line. Two binding screws receive the line connection and the earth wire. Having placed the galvanometer needle in the magnetic meridian, the switch is turned, throwing the current through the known resistance. Note the deflection. Then switch to line. If the galvanometer needle deflects less than before, the insulation has more ohms resistance than the standard coil. A switch enables the operator to use any number of cells, from one to the full number, so that within a somewhat limited range considerable accuracy may be attained. See fig. 5.

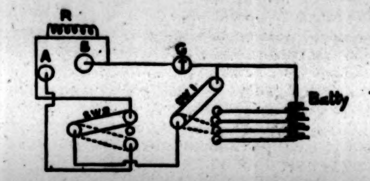


FIG. 5.—CHICAGO EDISON SYSTEM.

Every now and then the suggestion is made to place a permanent ground on an arc line, in order to know when a second ground occurs. The use of a safety fuse comes in at once as a natural sequence. The suggestion is fraught with great danger to both life and property, and takes no heed of the time it requires a good healthy current to "get there." While it is true that the first ground does no harm *per se*, it must be remembered that without a first ground a second ground is an impossibility, and the second ground is the troublesome one. There is a fascination about rigging up some sort of an arrangement for telling when there is trouble, rather than to keep the trouble at bay on general principles. An acquaintance brought to me one day, with his face all aglow, a sketch of a piece of clockwork, ingeniously arranged to make an instantaneous contact to ground once an hour while the plant was running. This ground contact had, between the line and ground, a safety device which held up a key to a second circuit that could only close when the fuse melted. On this second circuit he had a battery and a bell located so that every one in the room must hear it, and continue to hear it until it was switched out or the battery ran down. It never worked, for I convinced him of its impracticability by asking him to form the second ground through his body as an experimental test.

Testing sets are made by various firms, which do excellently well for the species of measuring which may be necessary about the station or on the line. The combination includes a Wheatstone bridge with a normal capacity up to over a megohm, and down to fractions of an ohm. With an additional box containing extra coils, and a split plug and cord attachment, this capacity may be carried to twice or three times its ordinary capacity. A battery and galvanometer finishes the set, which is made up in two portable cases. No electric light station or plant of any consequence should be without some such means of electrical measurement, and no dynamo should be run without a daily test of insulation and a test of copper resistance. A bad joint may cost many pounds of coal, but a ground leak may be far more expensive in many ways, while both may be prevented by the proper constant use of a set of testing instruments. A daily record should be kept of these tests, together with the condition of the weather, &c. I have read somewhere of a ladder which was seen in a dream, the three principal rounds of which are faith, hope, and charity, the greatest of these being charity. We have in the electrical ladder three principal rounds also. They are current, potential, and insulation.

THE EFFICIENCY OF THE ARC LAMP.[*]

By HATSUNE NAKANO.

Note.

THE interesting results recently obtained by Mr. Merritt in the application of the method of Melloni to the investigation of the efficiency of the incandescent lamp have made it seem desirable to extend that method to the study of the arc lamp also.

Existing data concerning the efficiency of this source of light are exceedingly imperfect, being based chiefly upon measurements with the Bunsen photometer. Ordinary photometric determinations of the light-giving value of sources of illumination differing widely in temperature from the standard candle are necessarily at fault; and I have endeavoured in a recent paper[†] to call attention anew to the character of the errors involved in the comparison of the light of the electric arc with that of other sources of artificial illumination.

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[*] A paper read before the American Institute of Electrical Engineers, New York, May 22nd, 1889, with an introductory note by Edward L. Nichols.

[†] "The efficiency of methods of artificial illumination." *Transactions of the American Institute of Electrical Engineers*, Vol. 6.

The efficiency of the arc lamp has been expressed hitherto in terms of the candle-power of light produced per unit of energy expended. The estimate has been based in a few instances upon the mean spherical candle-power, as actually determined; more frequently upon the candle-power emanating from the lamp in a single, especially selected direction, and in too many instances upon the "nominal candle-power." Such estimates of the efficiency of the arc are of small value. They afford us widely varying results which cannot be definitely compared, and even when they are based upon the most complete and careful determinations of candle-power and energy, they do not indicate the ratio of light-giving radiation to the total energy expended within the lamp. It seemed, therefore, to be of some importance to obtain measurements of the ratio of luminous to total radiation in the case of the arc lamp by a method the results of which would be directly comparable with those already obtained for the incandescent lamp.

FIG. 1.

The investigation was undertaken, at my suggestion, by Mr. Hatsuné Nakano, M.E., of the Imperial University of Japan, the results of whose measurements are given in the following pages.

E. L. N.

ON THE EFFICIENCY OF THE ARC LAMP.

The following experiments were made in the physical laboratory of Cornell University during the winter of 1888-89, the object in view being to determine the efficiency of the arc lamp.

It is a well known fact that the comparison of the candle-power of differently coloured lights, such as the candle and the electric arc, is only a rough approximation. By means of one of the methods recently described by Mr. Merritt,* however, we can determine the efficiency of the arc independently of its candle-power. The method in question enables us to find the ratio of the light-giving radiation to that of the total radiation of the lamp.

In his first experiments Mr. Merritt measured the heat given out by a lamp, which was immersed in the water contained in a calorimeter. It is evident that this method, though very ingenious, cannot be employed conveniently in the case of the arc lamp. His second method is, however, applicable to arc lamps as well as to incandescent lamps. This method and the arrangement of the apparatus were fully described by Mr. Merritt in his paper, read before the American Association for the Advancement of Science at their meeting in Cleveland. It was also described by Prof. Nichols in his paper read before the American Institute of Electrical Engineers, March 12th, 1889.

The application of the method to the arc lamp was as follows:—The rays of the lamp were allowed to fall upon the face of a delicate thermopile which was in circuit with a sensitive galvanometer. The deflection of the galvanometer was taken as a measure of the energy of the total radiation which fell upon the face of the pile.† After the deflection due to the total radiation had been measured, a glass vessel of rectangular shape one decimeter thick, containing a strong solution of alum, was placed between the lamp and the thermopile, and the reduced deflection of the galvanometer observed. The use of the alum cell was to cut off the "dark heat," and allow only the rays of the visible spectrum to reach the face of the thermopile. But a certain small percentage of the longer wave lengths passed through, and a considerably larger percentage of luminous rays were cut off by the cell. To determine the correction for the former source of error, a cell containing an opaque solution of metallic iodine in bisulphide of carbon was placed between the lamp and the alum cell. Any deflection now obtained was due to the dark rays passing through the alum cell, for the iodine cut off the luminous rays entirely, but allowed the dark rays to pass through. It was found that the dark rays which passed through the alum cell were exceedingly weak—almost imperceptible in most cases.

The correction for the second source of error, viz., the absorption of the luminous rays by the alum cell, was determined photometrically. The average of some 30 measurements gave 26 per cent. for the value of the correction.

In my first measurements, the lamp (the centre of the arc) and the thermopile were placed in the same horizontal plane. The lamp used was a "rack-feed" arc lamp requiring 45 volts and 9 ampères for its normal operation. Experiments were made with a dozen or more of different sizes of carbons, ranging from $\frac{2}{16}$ths up to about $\frac{13}{16}$ths inch in diameter.

The efficiency, or the ratio of the energy of the luminous radiation to that of the total radiation, luminous and non-luminous, in this plane was found to be exceedingly small, varying from about 5 per cent. to a little less than 15 per cent., the ratio increasing as the diameter of the carbons used decreased. This relation between the efficiency and diameter of the carbons, which is shown graphically by means of the curve in fig. 1 ceased to exist, however, when the point was reached at which the whole length of the carbons was rendered hot by the current passing through them. After this point was reached the efficiency fell off again.

Table I. gives the results of these measurements. In the first column the diameters of the carbons (in thousandths of an inch) are given. The second column shows the "mean horizontal efficiency;" that is to say, the ratio of the deflection produced by the total radiation of the lamp to that due to the light-giving radiation alone, after the proper corrections for absorption and diathermancy have been applied. Each value is the mean of a series of observations. The third column gives the potential difference between the terminals of the lamp.

TABLE 1.

Diameter of carbons. (In inches.)	Horizontal efficiency.	P. D. (Volts.)
·832	·01484	42
·730	·02162	45
·605	·02527	43
·563	·03125	38
·500	·03893	38
·432	·05014	38
·370	·05861	28
·305	·07338	31
·250	·0813	56
·185	·0458	25
·124	·0514	30

The curve, C, D, given in fig. 1, shows the relation between the efficiency, measured in the horizontal plane, and the diameters of the carbons. The ordinates represent efficiencies, and abscissæ the diameters. It will be noticed that the points, A and B, corresponding to $\frac{3}{16}$ths and $\frac{2}{16}$ths inch carbons, are far below the curve, showing that the relation is modified as soon as the carbons become too small to carry the current without heating.

FIG. 2.

In the electric arc, as Prof. Nichols has shown in the paper already referred to, "the entire light-giving area is included between the line surrounding the positive carbon, which is at red heat, and the corresponding line upon the negative carbon. Now the surface of total radiation is much larger than that from which the light-giving rays emanate. It includes, in addition to the incandescent surfaces near the arc, all those portions of the carbons which are heated, either by conduction or by the current. Were the distribution of total radiation in the vertical plane identical with that of the light-giving rays, the measurement of their ratio with the axis of the thermopile in any plane which passes through the arc would give us the efficiency of the lamp, but the curve of distribution of total intensity is not the same as that of candle-power, and the ratio in question is a function of the angle which the axis of the pile makes with the horizon. It becomes necessary, therefore, to make an exploration of the entire zone through which the lamp sends out rays, determining the ratio of luminous to total radiation for each angle, and then to integrate the results."*

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* Ernest Merritt: "Some determinations of the energy of the light from incandescent lamps. *American Journal of Science*, Vol. 37, p. 167.

† John Ericsson, in his "Contributions to the Centennial Exhibition," 1876, says that the calorific energy imparted to a thermopile is not proportional to the arcs through which the needle of the galvanometer sweeps, as stated by Melloni, but that for deflections not exceeding 15°, the calorific energy imparted to the pile by radiant heat is very nearly as the square root of the versed sine of the angle of deflection; the deflection of the needle at the termination of the first degree exceeding the energy transmitted, in the ratio of 100 to 89, and beyond 90 minutes the energy becoming greater than the deflection in a constantly increasing ratio. Ericsson does not state, however, what kind of galvanometer he used in his investigations. The one used by me was a low resistance reflecting galvanometer of Sir William Thomson's pattern. It had been tested by Mr. Merritt, who found that the deflections were proportional to the energy imparted to the pile. In my experiments this proportionality was assumed to be true.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

With such an object in view, the piece of apparatus which is shown in fig. 2 was devised. The lamp was hung from a horizontal beam, *a*, supported by two upright pieces, *b*, *b*, which could be kept always vertical by means of a "parallel motion" arrangement. The alum bath, A, and the thermopile, P, were also carried upon a board, pivoted at *c*, *c*, so that it could be turned to any desired angle. All necessary changes of angle could be made without altering the distance between the arc and the thermopile, or the relation of the alum cell to either of them. By means of this apparatus measurements were made at angles of 0°, 10°, 20°, 30°, 40°, 50, 60° and 63° below the horizontal planes. The following carbons were used:

(1) Uncoated carbons ... diameter = ·832 inch.
(2) " " ... " ·563 "
(3) Copper-plated carbons... " ·500 "
(4) " " ... " ·450 "
(5) Uncoated carbons ... " ·370 "
(6) Copper-plated carbons... " ·250 "

The results of these measurements are given in Tables 2, 3, 4, 5, 6 and 7, and curves showing the distribution of luminous and total radiation, emanating from the lamp under the above conditions, are given in figs. 3, 4, 5, 6, 7 and 8.

The radii show the positions for which measurements were taken and distances measured along these lines from the origin to each curve give the intensity of luminous and total radiation in each position. The curves of luminous radiation are similar in form to those of candle-power. Note, for purposes of comparison, the set of curves of candle-power at various angles published by M. Schreihage,† of the Polytechnic School at Braunschweig, who has made extended measurements of lamps with different sizes of carbons. In the following tables D is the deflection for total radiation, *d* that for light-giving radiation (corrected).

TABLE II.

Carbon (unplated), diam. = ·832 inch.

Angle.	d	D	$\frac{d}{D}$	P. D. (Volts).
0°	4·	220	·0182	44
10°	6·8	265	·0256	42
20°	16·4	300	·0547	42
30°	27·3	350	·0780	40
40°	35·1	390	·0900	40
50°	27·3	330	·0827	38
60°	20·3	300	·0677	39
63°	5·4	125	·0432	39

TABLE III.

Carbon (unplated), diam. = ·563 inch.

Angle.	d	D	$\frac{d}{D}$	P.D. (volts).
0°	6·8	165	·0412	41
10°	10·8	195	·0554	42
20°	22·9	245	·0956	43
30°	32·8	264	·1242	39
40°	39·2	274	·1441	42
50°	28·4	252	·1137	41
60°	10·8	128	·0625	40

TABLE IV.

Carbon (copper plated), diam. = ·5 inch.

Angle.	d	D	$\frac{d}{D}$	P.D. (volts).
0°	5·4	110	·0491	45
10°	12·2	140	·0872	45
20°	21·5	172	·1250	45
30°	29·7	190	·1563	45
40°	33·8	195	·1733	45
50°	20·3	155	·1310	45
60°	4·1	93	·0441	45

TABLE V.

Carbon (copper plated), diam. = ·45 inch.

Angle.	d	D	$\frac{d}{D}$	P.D. (volts).
0°	10·8	197	·0548	45
10°	20·3	225	·0901	45
20°	29·7	242	·1228	45
30°	39·2	260	·1506	45
40°	41·9	270	·1552	45
50°	27·3	255	·1059	45
60°	12·2	180	·0676	45
63°	5·4	110	·0492	45

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* Edward L. Nichols, l. c.

† Schreihage, *Centralblatt für Elektrotechnik*, No. 22, 1888. See also *La Lumiere Electrique*, T. 29, p. 585.

TABLE VI.

Carbon (unplated), diam. = ·37 inch.

Angle.	d	D	$\frac{d}{D}$	P. D. (Volts).
0°	10·	180	·0555	40
10°	14·9	190	·0789	42
20°	24·4	200	·1220	38
30°	31·8	217	·1474	37
40°	39·2	230	·1696	40
50°	42·	240	·1750	42
60°	33·8	205	·1659	42
68°	10·8	115	·0869	38

TABLE VII.

Carbon (copper-plated), diam. = 25 inch.

Angle.	d	D	$\frac{d}{D}$	P. D. (Volts).
0°	13·5	160	·0844	37
10°	22·9	185	·1238	37
20°	39·2	225	·1742	39
30°	45·9	255	·1800	38
40°	41·9	230	·1822	38
50°	29·7	150	·1980	39
60°	4·1	75	·0547	38

FIG. 7. FIG. 8.

FIG. 9.

The distribution of total radiation differs widely from that of luminous radiation, so that the efficiency expressed by their ratio depends upon the angle of measurement. The values of the efficiency in each case for the various angles at which measurements were made have been calculated. They are shown in the diagram of efficiencies in fig. 9.

In order to determine the mean or "hemispherical" efficiency of the lamp the ratio of the radii of two semi-circles, the areas of which equal the areas of the curves of total and luminous radiation, was found by means of a planimeter. The following are the values thus obtained:

TABLE VIII.

Diameter of carbons.	Spherical efficiency.
·832	·0687
·563	·1100
·500	·1266
·450	·1330
·370	·1554
·250	·1660

The above table forms the basis of the curve shown in fig. 10, which represents the relation between the diameter of the carbons and the "hemispherical" efficiency of the lamp. The diagram is a straight line. Thus we see that the hemispherical efficiency varies inversely as the diameter of the casbon.

FIG. 10.

It will be interesting to compare this with the result of M. Schreihage's experiments. He measured the mean spherical candle-power with the different sizes of carbons, and found the same relation to hold true, as will be seen from the following table:

TABLE IX.—M. SCHREIHAGE'S MEASUREMENTS OF CANDLE-POWER AND CURRENT DENSITY.

Cross-section of positive carbon. mm.	Diameter d. mm.	Spherical C.P.	d. × C P.	Current density.
40	7·12	417	3,353	0·134
95	11·0	383	3,128	0·066
134	13·6	254	3,462	0·047
194	16·1	189	3,045	0·032
254	18·0	161	2,905	0·25

M. Schreihage states that this relation is not completely satisfied in the case of the mean horizontal candle-power, especially when the carbons are very small or very large. We have seen that this statement applies also to the experiments upon the horizontal efficiency described in the first part of this paper.

NEW PATENTS—1889.

13047. "Improvements in arc lamps." J. H. RIDER. Dated August 19.

13057. "Apparatus for giving temporary use of telephones in exchange for coin." B. MARINOVITCH and G. SZARVADY. Dated August 19.

13069. "An improved light field telegraph." A. GLEN. Dated August 20.

13135. "Improvements in coin-controlled apparatus for use in connection with telephones." H. H. LAKE. (Communicated by W. Gray and C. Soby, United States.) Dated August 20. (*Complete.*)

13148. "Improvements in alternating current electric motors." T. PARKER, J. H. WOODWARD and E. S. G. REES. Dated August 20.

13149. "Improvements in apparatus for obtaining reciprocating motion from electric currents applicable to the operation of electric bells, hammers, caulking tools or the like." T. PARKER. Dated August 20.

13172. "Improvements in conduits for laying underground electrical conductors, and in the means for supporting, guiding and insulating the said conductors therein, and in clips for holding together the strips of conductors constructed of thin strips of metal." F. V. ANDERSEN. Dated August 21. (*Complete.*)

13183. "Improvements in apparatus and in the combination thereof for lighting railway carriages, tramcars, and other vehicles by electricity." J. RADCLIFFE. Dated August 21.

13191. "An electro-magnetic protector for electrical instruments." T. A. D. FORSTER. Dated August 21.

13223. "Improvements in electrodes and filaments for electric lamps, and in materials for the same." C. W. BEESLY. Dated August 22.

12858. "An improved method of carrying main leads and other electric wires along streets and other thoroughfares." W. SMETHURST. Dated August 23.

12866. "Improvements in electric arc lights." C. WELLS and J. BROWN. Dated August 23.

12871. "Improvements in single needle telegraphs and other electric instruments." T. H. PARKER and G. W. FAIRALL. Dated August 24.

12882. "An improved electric alarm or water level indicator, chiefly applicable to the water gauges of steam boilers." M. BECKERS. Dated August 24. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1888.

10900. "An improved electric alarm for varying levels and pressures." A. SIEGMANN. Dated July 27. 6d. As the level of the water rises, or the pressure of the steam increases, an index pointer, in its movement over the dial plate, comes in contact with a non-oxidisable metal plate, closes an electrical circuit, causing an electric bell to ring. 1 claim.

13403. "Improvements in the construction of secondary batteries." S. A. VARLEY. Dated September 17. 8d. Claims:—1. Producing a block of lead or a suitable alloy of lead metallically united in one solid mass, but at the same time intimately mixed throughout with oxide of lead or other matter, and having small interstices, and which can be afterwards sawn up into plates for the construction of secondary batteries, substantially as described. 2. Producing such blocks by placing them in an airtight chamber and subjecting them to pressure when the lead or a suitable alloy of lead is in a melting condition, substantially as described.

13615. "Improvements in or relating to cases for electrical batteries or cells." G. B. SATTERLEE. Dated September 20. 8d. The inventor constructs the case in the form of a cylindrical tube, preferably of hard rubber or ebonite of proper thickness in proportion to its diameter, and he makes the bottom thick enough to hold well and firmly the terminal of one of the elements which is inserted tightly through the bottom, to give an exterior connection to that element, while the element is firmly held and supported by said terminal and the bottom of the case. He constructs a circular cover or head of the same material, the top of which is of a diameter a little less than that of the outer periphery of the case, but the lower part is cut away sufficiently to fit tightly in the mouth of the case, leaving a shoulder on the cover, and thus forming a flat circular stopper which fits into the mouth of the case. This cover is sufficiently thick to receive and hold, fitted tightly through it, the terminal of the other element, thus supporting that element and giving an exterior connection to the terminal. 4 claims.

13621. "Improvements in electric meters." S. Z. DE FERRANTI. Dated September 20. 8d. Relates more especially to the class of alternate current meters in which an unwound magnetic armature is employed, and is magnetised by coils so as to produce diametrically opposite poles, and in which the armature so magnetised is contained in a magnetic field induced by other coils, from which arrangements movement results. In such meters it has been usual for the armature to be a light disc of iron in one piece, but so constructed the meters do not perform well. The inventor obtains much better results by using a heavier armature, built up in layers or of laminæ, insulated the one from the other. In order to lessen the friction on the pivot which otherwise would result from the increase of mass, he partially floats the armature in a liquid. 7 claims.

17123. "Improvements in apparatus for electrically regulating or synchronising clocks." C. A. MAYRHOFER. Dated November 24. 8d. Relates to a device by means of which any number of clocks can be regulated from a central station by electro-mechanical means. To form the electrical connection, any existing network of electrical lines or conductors, such as telegraphic or telephonic, or fire alarm signal circuits, or the like, may be used. The central station is provided with an apparatus suitable for transmitting an electrical impulse simultaneously to a large number of circuits. 5 claims.

1889.

135. "Improvements in the arrangements for lighting and, or braking railway vehicles electrically." I. A. TIMMIS. Dated January 3. 8d. The objects of the invention are:—(1) To economise the electric current. (2) To make the lighting automatic on the breaking away of a vehicle. (3) To make the breaking automatic on the breaking away of a vehicle. (4) To keep both lighting and braking under the control of the guard or authorised official. 5 claims.

288. "Improvements in alternate current dynamo-electric machines." J. D. GIBBS and E. FESQUET. Dated January 5. 8d. The electro or field magnet consists of a coil wound on a mass of soft iron carried by a spindle, which is rotated and provided with means (such as brushes bearing upon collars on the spindle) for conducting the current to the coil. At each end of this core is formed or fixed a flange or collar having pole pieces which extend over the coil parallel with the spindle to, or nearly to, the full width of the coil, the pole pieces of the flange or collar at one end of the coil being situated between the pole pieces of the flange or collar at the other end of the coil with a clearance between them, the poles of opposite denominations thus alternating with each other around the coil. The spaces between the pole pieces may be filled in with a non-magnetic or insulating material to constitute a continuous outside surface. The armature is preferably built up of thin sheets or plates of iron, insulated from each other, and with inward projections (corresponding in number to the pole pieces of the field magnet) on which are wound the coils for the induced current or currents, which coils are connected up in any desired manner, according to the resulting induced current or currents required to be produced. The plates can be connected together, and to a suitable frame, by insulated bolts. 3 claims.

1118. "Improvements in apparatus for automatically switching loop circuits out of or into the main electric circuits." E. A. SPERRY. Dated January 22. 8d. Employs the differential action of ingoing and outgoing currents to change the line connectors to a new loop circuit. 9 claims.

2080. "Improvements in and relating to electrical apparatus for medical purposes." H. H. LAKE. (Communicated from abroad by L. T. Stanley, of Brooklyn.) Dated February 5. 8d. The object of this invention is to combine in a small compass and portable form an induction coil, a galvanic battery, and suitable electrodes for applying the current to any desired part of the human body. 10 claims.

2480. "Improvements in and relating to apparatus for measuring electric currents." H. H. LAKE. (Communicated from abroad by H. H. Cutler, of America.) Dated February 12. 1s. 1d. The device employed for indicating the quantity of current consists essentially of two wires substantially similar to one another in diameter, length and material, and subjected to equal tension in the direction of their length, one of which wires is traversed by the current to be measured, and is thus heated and is caused to expand by the current flowing through it, the amount of said expansion varying with the amount of the current. 7 claims.

3808. "Improvements in electric signals for indicating the direction and speed of revolution of engine shafts." J. C. RICHARDSON. Dated March 5. 8d. Is, in part, an improvement on the devices set forth in patent No. 16,742, December 6th, 1887. 2 claims.

4654. "Improvements in meters for electricity." J. CAUDERAY. Dated March 16. 11d. Has as its object modifications in the meters described in previous patents, Nos. 1,756, 1883; 7,515, 1884; 13,704, 1885; 6,369, 1886; and 12,332, 1888. 6 claims.

5084. "Improvements in electric clocks with synchronising mechanism." A. J. BOULT. (A communication from E. Pouchard, of Paris.) Dated March 23. 8d. Relates to electric clocks by means of which all clocks included in the same electric circuit can be synchronised. 4 claims.

5737. "Improvements in holders for electric glow lamps." A. BERNSTEIN. Dated April 3. 8d. Claims:—1. A holder for glow lamps in series, comprising a switch piece, which, when no lamp is in the holder, is adapted to form a short circuit for the current, and which, when a lamp is in the holder, serves to cause the current to pass through such lamp, and prevents the removal of the same until the current has been again short circuited, substantially as described. 2. The manufacture and use of the improved lamp-holder, described and illustrated in the drawing.

6065. "Improvements in and relating to electric motors." H. H. LAKE. (Communicated from abroad by Prof. Elihu Thomson, of America.) Dated April 9. 8d. Consists of improvements more particularly in that class of alternating current motors in which the armature is wound with a coil or coils short-circuited or connected into a closed local circuit, and is placed within the inductive action of a field magnet whose poles are made first north and then south by the effect of alternating currents derived from any source. In this general class of motors the reaction set up between the induced currents in the armature (which currents have a lag or retardation owing to their self-induction) and the field produces continuous rotation by repulsive action. The communicator has discovered, however, that when the armature coils are kept on continually closed circuit, and a single set of [illegible] coils only is employed, supplied by a single [illegible] that effective rotation may nevertheless be [illegible] ture be brought up to a certain speed. [illegible] consists in the combination of a set of [illegible] with an alternating current of [illegible] coils, and a set of coils inductively [illegible] continually closed, [illegible] motor is running, one or the [illegible] being movable as in [illegible]

6264. "Improvements [illegible] Dated April 13. 6d. The [illegible] attracted by the core of the magnet wound with wire, included in or taken as a shunt from the circuit to be governed, to actuate a tumbler or kicker so that the said tumbler or kicker, being overbalanced, falls over and acts on the bridge or contact makers to quickly and with certainty remove them from the mercury cups or contacts. 2 claims.

6622. "Improvements in electrical switches, fuses, cut-outs, ceiling roses, lampholders, and the like." F. G. Howard, J. Appleton, W. T. Burbey, and A. E. Williamson. Dated April 18. 4d. Claim:—Covering or enveloping cases or covers of electrical switches, fuses, cut-outs, ceiling roses, lampholders, and the like, made of china, earthenware, or other suitable material, with metal cases for decorative and other purposes, substantially as described.

6680. "Improvements in electric railways." G. E. Vaughan. (Communicated from abroad by S. Trott, of Halifax, Nova Scotia.) Dated May 4. 8d. Consists in mounting and connecting the conductors in grooves in the upper part of insulators, which are preferably formed of glass or porcelain, and are similar in construction to ordinary telegraph pole insulators—that is to say, their under surfaces are concaved. The said insulators are carried by vertical pins or screws, which are fixed in the bottom of the conduit when employed, or in any other base or support. 5 claims.

6804. "Improvements in telephone transmitters." W. R. Lake. (Communicated from abroad by J. Straton, of Canada.) Dated April 23. 8d. Relates especially to that class of telephone transmitters which are provided with pivoted electrodes, and it consists in certain novel features, the object being to produce a simpler, cheaper, and more effective device of this character than is now in ordinary use. 9 claims.

6854. "Improvements in means connected with electrically lighting trains, sections of railway tracks, stations *en route*, and signals, all from a single source of energy in a train, and in the distribution of electricity to stationary motors, storage batteries, and the like." H. W. Leonard. Dated April 24. 8d. The lights are so arranged along the track and on the wires that they are extinguished and lighted in succession, and the ventilating and signalling for the train can be done from the same generator. 39 claims.

7002. "Improvements in electric secondary or storage batteries." T. H. Hicks. Dated April 26. 6d. Claims:—1. A secondary or storage battery consisting of a series of elements having tight cells containing the electrolyte formed between them, by means of insulating material forming the bottom and sides of the cells, and insulating the plates from each other, substantially as described. 2. A secondary or storage battery consisting of elements or plates insulated from each other by insulating frames, clamped between the outer edges of the plates, and forming tight cells containing the electrolyte, substantially as described. 3. In a secondary battery, a series of elements insulated from each other and dividing the battery into tight cells, each element between two adjoining cells forming a positive pole in one cell and a negative pole in the adjoining cell, substantially as described. 4. A secondary or storage battery consisting of the elements or plates, the pole plates secured to the outer plates and carrying the binding posts, the frames of insulating material forming the sides and bottom of the cells between the plates, and the iron frames and clamping bolts all arranged substantially as described. 5. The herein described method of constructing secondary batteries, consisting of clamping frames of insulating material between the outer edges of the elements or plates, to form tight cells for containing an electrolyte and insulating the elements from each other, substantially as described. 6. In a secondary battery, an element or plate provided upon its faces with troughs, filled on one side of the plate with oxide of lead and on the other with peroxide of lead, substantially as described.

7129. "Improvements in electric arc lamps." A. J. Howes. Dated April 29. 6d. Claims:—1. An arc electric lamp wherein the regulation of the arc is effected by the action of a solenoid having its coil in the lamp circuit on an iron core attached to the upper carbon, operating in combination with a steadying brake, substantially as described. 2. In an arc lamp such as is referred to in the preceding claim, a steadying brake consistng of a nut with part of it non-magnetic screwed on the tube of the core, substantially as described. 3. In an arc lamp such as is above referred to a steadying brake consisting of an iron segment fixed on one side of the solenoid at its lower part, substantially as described. 4. In an arc lamp such as is above referred to, a steadying brake consisting of an iron segment supported from the solenoid core at height corresponding or nearly corresponding with that of the top of the core, substantially as described. 5. In an arc lamp such as is above referred to, a steadying brake consisting of a long solenoid core parallel to and moving with the operating core within the same solenoid coil, substantially as described.

7356. "Improvements in galvanic or primary batteries." C. Maltby-Newton. Dated May 3. 6d. Consists principally in employing plates constructed or compounded of oxide of lead and syrup of sugar or molasses, formed upon an inner metal support as the positive pole of the battery, thus forming the positive pole and depolariser in one plate, together with a strong solution of caustic soda of 30 to 50 per cent. 1 claim.

7526. "An automatic compensating feed electric arc lamp." A. U. Alcock and H. Galopin. Dated May 6. 8d. Claims:—1. In an electric arc lamp; an automatic clutch feed device for regulating the descent of the upper carbon; constructed, arranged and operated substantially as described with reference to the drawings. 2. In an electric arc lamp; an automatic compensating balance for the upper carbon; constructed, arranged and operated substantially as described with reference to the drawings.

7597. "Dry galvanic cells." C. H. Mehner. Dated May 7. 4d. Claim:—The manufacture of dry cells, the employment of deliquescent oxy-chloride of magnesia, with or without the addition of sulphate of zinc, which mixture is in itself an excitant, for the purpose of transforming the exciting fluid used into a stiff pasty or viscous mass, which has no flowing properties, substantially as described.

7619. "Improvements in and connected with electric batteries." W. J. Starkey Barber-Starkey. Dated May 7. 6d. According to these improvements, the positive and the negative plates or electrodes are embedded in or surrounded and separated by a porous substance which is saturated with the solution of sulphuric acid or other electrolytic solution. It is preferred to employ calcined calcium sulphate or plaster of Paris as a basis of the porous material, especially in the case of batteries in which a solution of sulphuric acid is employed as the electrolyte. The natural porosity of the plaster of Paris (when gauged and set) is increased for the purpose of this invention by the addition thereto of certain materials, such as crystals of salt soluble in water or in the electrolyte, and which are dissolved out of the plaster after it has set; salts which are decomposed by the electrolyte or by a suitable acid, and having as one of the products of the decomposition a gas such as carbon dioxide; or by the addition of an insoluble fibrous or porous material, such as sawdust, pith, cork, asbestos, wool, hair, felt, pumice stone, and similar substances. 4 claims.

7645. "Improvements in underground conduits for electrical conductors." G. W. Cook. Dated May 7. 8d. Claims:—1. In a conduit for electrical conductors, in combination with an outer conduit of an inner conduit or conduits of like paper tubes fitted one within the other, substantially as described. 2. A conduit for electrical purposes, consisting of a series of like paper tubes saturated with paraffin and taper-jointed together. 3. In an underground conduit the combination of the following elements: an outer casing or box of substantially rectangular shape, insulating cross bridges placed therein at intervals, an inner conduit or conduits consisting of paraffin, taper-jointed paper tubes supported upon said cross bridges, and an insulating water-proof compound filled into the outer conduit, substantially as described. 4. The inner conduit consisting of a series of asbestos paper tubes, substantially as described. 5. An underground conduit for electrical conductors, consisting of tubes tapering from one end to the other, and adapted to be taper-jointed together, substantially as described.

7647. "Improvements in electric motors and dynamo-electric machines." S. S. Wheeler. Dated May 7. 8d. Relates chiefly to governors, by the action of which the revolving armature of the dynamo can be withdrawn sideways more or less out of the field-magnets and a dummy armature drawn in. 9 claims.

7673. "Improvements in electric wire insulators." A. W. Heaviside. Dated May 8. 6d. The inventor lets the insulator and bolt move at either end upon an axis or attachment to the arm of a pole or other support, whilst the wire is fastened to the other end, and by its tension pulls the insulator round so as to bring the wire to the same level as the axis. 2 claims.

8046. "Improvements in electrical fire alarms." H. E. Newton. (Communicated from abroad by W. Birchall, of Melbourne.) Dated May 14. 4d. Claims:—1. The completion of an electric circuit by the fusing of an alloy of metals as specified, and for the purposes set forth. 2. A metal chamber in electrical contact with one wire of an electric battery, but insulated from the second wire, or its attachment, and containing a metallic alloy, which, when fused, makes contact with the second wire, and closes an electric circuit, as specified, and for the purposes set forth.

8053. "Improvements in electrical signalling apparatus." O. Imray. (Communicated from abroad by A. W. Jones, B. F. Jones, and E. L. Martin, all of America.) Dated May 14. 8d. In warfare, various means have been contrived for exploding torpedoes and mines at the exact time when their destructive power is greatest. The invention is especially applicable for this purpose, by connecting the conductor to the explosives through apparatus so arranged that any one of the explosives can be fired without affecting the others. 5 claims.

8360. "Improvements in apparatus relating to telephone systems." F. A. Holcomb. Dated May 20. 8d. Has for its object to provide devices whereby a subscriber can be notified that he has been called, and by whom the device by means of which this information is recorded being controlled by another subscriber or by an operator at the central office. 7 claims.

8619. "An improved electrical alarm for audibly indicating and announcing the varying water levels of steam boilers and the like." A. Siegmann. Dated May 23. 6d. Relates to a modification of Patent No. 13,974, of 14th October, 1887. 1 claim.

ON ELECTROLYTIC POLARISATION BY METALS.

(*Comptes Rendus.*)

Note by M. N. PILTSCHIKOFF,* presented by M. LIPPMANN.

IN order, to explain the delay in electrolysis discovered by M. Lippmann† in an electrolytic system in which the properly so-called chemical work is compensated, as I said in my former note, we must have recourse to the consideration of the molecular work. Resting upon the principle of the conservation of energy, I expressed the electromotive force, ϵ, that is antagonistic to the electrolysis, as a function of the molecular energies, Q_1 and Q_2, of the anode and cathode,

$$\epsilon = A\,(Q_1 - Q_2),$$

in which A is the chemical equivalent of the electricity. This being admitted, I thought that every modification in the physical condition of the surface of the cathode must influence the adherence of the electrolytic deposit, and consequently the energy, Q_2. In fact, I observed the changes of ϵ depending on this cause, as I have already said. Now, in the above equation another variable term enters; this is the energy, Q_1, of the anode; it was therefore interesting, in order to verify the proposed explanation of the hindrance to the electrolysis, to try whether the physical condition of the anode also influences the value of ϵ. Experiment shows that the value of the antagonistic force, ϵ, changes in accordance with what can be foreseen *à priori*—thus, for example, by keeping in the system Pt, Cu, Cu SO_4, the surface of the platinum cathode always the same, I determined $\epsilon = \cdot038^{\mathrm{dll}}$ for the compact copper anode, and $\epsilon = \cdot025^{\mathrm{dll}}$ for the anode of crystalline electrolytic copper. Variations of the same order correspond to other cases in which ϵ is an antagonistic force.

We may also ask if the difference of potential η applied to the electrodes in a system with compensated chemical work is smaller than the antagonistic force, ϵ, what will result?

There is no doubt that we shall observe the polarisation of the electrodes, but by what is it produced? Is it hydrogen alone that polarises the cathode, or is it also the metal of the electrolyte? *The experiments that I have made show that the metal accumulates on the surface of the cathode.* Generally, when the electrodes are polarised, the ions which accumulate upon their surfaces are not visible, because several physical agents tend to destroy the effect of this accumulation. Amongst these agents we may mention as the most important the dissolution of the ions by the electrolyte itself. This cause, which is so efficacious with gaseous ions, acts much less powerfully upon those consisting of solid bodies not easily soluble in the electrolyte. We may therefore hope in these cases that the electromotive force necessary to produce a visible electrolytic deposit will be a continuous function of the time that elapses between the closing of the current and the appearance of this deposit.

Let us take the system, Pt, Cu, Cu SO_4. The delay in the appearance of the copper upon the platinum becomes greater in proportion as we diminish the electromotive force applied to the electrodes. Thus, I have seen the deposit appear with $\eta = \cdot028^{\mathrm{dll}}$ at the end of half an hour; with $\eta = \cdot023^{\mathrm{dll}}$ at the end of an hour; with $\eta = \cdot006^{\mathrm{dll}}$ I had to wait more than 40 hours before I observed the appearance of the first particle of copper (about $\frac{1}{2}$ a micron in diameter, which establishes the limit of power of the method I employ).

The influence of the physical condition of the electrodes in the slow formation of the accumulation of the cathion seems to be still more essential than in the immediate production of their deposit; the numbers quoted relate to the case in which the anode was of compact copper; with the anode of crystalline electrolytic copper the accumulation is produced much faster, and with $\eta = \cdot0025^{\mathrm{dll}}$ I observed at the end of 40 hours a deposit in a considerable stage of development.

The system, Au, Zn, Zn, SO^4, acts in the same manner. From what I have said, it follows that "*a metal can be polarised by another metal.*"

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* These experiments were made at the laboratory of Physical Research at the Sorbonne.

† *Journal de Physique*, 1879, p. 59.

CORRESPONDENCE.

Electric Traction.

Your readers ought to be very thankful to Mr. Harry Willis for reminding them "that this is a free country" and for the suggestion that Mr. Fraser can please himself about answering a question Mr. Harry Willis put to him.

Perhaps Mr. Harry Willis will not object to answer the following questions, as a satisfactory reply thereto will sure to prove of interest to a number of your readers and the public, as the origin and development of the so-called Sandwell system is not altogether unknown to many persons in the electrical world.

1. What was the real cause of the breakdown of Sandwell's car in the Holloway Road? Was it due to an explosion in the truck? Did any of the lugs of the cells burn out? or, was it due to the cells becoming exhausted as has been stated by a person who was present on that memorable occasion?
2. Was there a very great difficulty experienced in removing the car, &c., from the line which caused the horse-drawn cars to pull off because of the obstruction the breakdown caused?
3. Why was the car, &c., allowed to stand so long in an adjoining street before being dragged to its secluded spot in the Victor Road?
4. Has Mr. Harry Willis ever seen the illustrated description of a car and trolley in the ELECTRICAL REVIEW for April 13th, 1888. Does not this anticipate the so-called Sandwell system in its entirety?

If these questions are satisfactorily answered, I may perhaps ask Mr. Harry Willis a few more, because it is just as well that your readers and the public should know something of the Holloway failures as well as the little *contretemps* at Plaistow, as it will enable them, as Mr. Harry Willis remarks, "to satisfy themselves of the merits of the two systems."

John Willis.

August 29th, 1889.

Inductive Capacity of Electro-magnets.

I shall feel obliged if you will, in any issue of your Journal after the receipt of this, answer the following questions as clearly as possible.

A Student.

Madras, *July 13th*, 1889.

Questions.

1. What is the magnetic inductive capacity in microfarads of a Siemens's universal polarised relay of 500 and 1,000 ohms; also of a non-polarised relay of the same values?
2. Explain in a simple manner the law of magnetic inductive capacity in the above relays.
3. What influence has the resistance of the coils on the inductive capacity, if of uniform gauge, size and shape?
4. What influence has the size of the cores and the strength of the current on the inductive capacity?

5. If each of the relays in No. 1 were armed with a condenser as a shunt, what capacity would have to be given the latter to counterbalance the discharge from the relays?

6. If when a current of 20 milliampères passed through a relay, what would be the shunt capacity in No. 5?

7. What capacity would be required in the differential system of quadruplex working as shunt condenser on an aerial line of 800 miles of iron wire, having a per mile resistance of ·10 ohms, and one of phosphor bronze, or American compound copper wire having a resistance of 5 ohms per mile, the working currents being 5 and 15 milliampères?

[*Answer* 1. The magnetic inductive capacity in microfarads of a Siemens's relay wound to 500 ohms is 40 microfarads approximately, and of a similar relay wound to 1,000, 20 microfarads; these values, however, depend upon the position of the pole pieces of the relay, being increased if they are set closer together, and diminished if they are opened out. It is impossible to give the value of a non-polarised relay, as the varieties of these are legion. The way in which these values are arrived at is fully explained in an article on "The Measurement of Self Induction Coefficients," which appeared in the No. of the REVIEW for April 12th of the present year, page 410.

2. The inductive capacity of an electro-magnet depends *directly* upon the number of turns of wire in it, and *inversely* as the resistance of the same; the resistance (the total *weight* of wire being constant) varies as the square of the number of turns, hence the inductive capacity varies *inversely* as the resistance.

3. The inductive capacity varies inversely as the specific resistance of the metal (provided the latter is not a magnetic one like iron).

4. The greater the mass of iron in the cores (within a certain limit), the greater will be the inductive capacity. Strength of current has no influence on inductive capacity, provided the magnetism of the iron does not approach the saturation point.

5. See article in REVIEW referred to.

6. Strength of current makes no difference, provided saturation point is not approached.

7. For quadruplex working over an iron wire 800 miles long, having a resistance of 10 ohms per mile, a condenser of about 10 microfarads would be required; for a copper wire of the same length, and having a resistance of 5 ohms per mile, about 10 per cent. less condenser capacity would be necessary. Current strength makes no difference, as the saturation point is never even approached in telegraph working.

Care should be taken not to confuse the inductive capacity in microfarads of an electro-magnet with its coefficient of self induction; the latter is obtained by multiplying the inductive capacity in microforads by the square of the resistance, and dividing the result by 1,000,000; the difference between the two is fully explained in the article referred to.—EDS. ELEC. REV.]

Coad's Primary Battery.

Our client, Mr. T. Coad, has brought us your number of August 30th. Our client complains of an editorial note, which he feels is calculated to bring him into ridicule.

We think it will answer every purpose if we point out to you that you treat our client (whom you style "our old friend") in a very unfriendly and sarcastic manner, and that your paragraph may produce an unpleasant impression upon persons who may be better acquainted with the result of Mr. Coad's present efforts. We trust, therefore, to your sense of fairness (as we judge, and understand, that you have not made yourself acquainted with Mr. Coad's present work), that you should, in a subsequent issue of your valuable paper, correct any wrong impression that may have been conveyed.

We need hardly say that Mr. Coad would be only too pleased to instruct you as to his present under
and he cordially (through us) invites you to
form an opinion on the same.

We write you in the hope that you will treat
the spirit in which it is meant, and that there
no necessity for any further action on our part.

Mann & Tayl

Bank Chambers,
New Oxford Street, W.C.,
September 3rd, 1889.

[We quite accept the letter of our correspondent
the spirit in which we think it is intended. If
Coad will instruct us more fully as to his present
taking, we shall be happy to reconsider our op
thereon; and if he has any new discovery or inve
we shall be pleased to view it here, and, possibly,
it also, and then publish an unbiassed report of
our columns.—EDS. ELEC. REV.]

The Institution of Electrical Engineers.

In your issue of the 30th inst., you mention the
perience of a well-known engineer with respect
voting paper sent out by the secretary of the Instit
of Electrical Engineers, allow me to state that my
was treated exactly in the same manner, thereby ca
me to lose my vote. Whether this has been the f
all the papers, and we are to suppose it has,
"contrary to regulations" or not, I think an exp
tion to all the members of the institution ought to
been issued by those responsible for the draughtin
the circulars.

W. C. Garrard, A.I.E.

August 31*st*, 1889.

I have just read the paragraph in your last
relating to the return through the Post Office of
of the replies to my circular in reference to the mod
electing the council. I have reason to believe
nearly all of those which were so returned have
been again kindly forwarded to me by the memb
from whom they emanated, and to each of whom I h
written expressing my regret at the misunderstand
which has entailed this trouble on them.

I am glad of this opportunity of explaining th
was not until many of the replies (bearing a halfp
stamp) had been delivered without any surcharge,
the letter-carrier coming from one particular post-o
brought several marked, "Of the nature of a le
and therefore requiring the payment of a penny
each. He was asked to take them back to the p
office and keep them until I could make enquiries a
the correctness of the demand.

I called as soon as I could, and then found to
vexation and surprise that the circulars had been
turned to their senders. I gave instructions at o
that thenceforth the surcharge was to be paid wh
ever demanded. I should mention that during t
time—and, in fact, on nearly every day since—circu
replies have been delivered from other post-offi
without any demand for deficient postage. The circu
is so similar in character to that in connection with
proposed dinner that I certainly never anticipated
it would be looked upon as of the nature of a le
and I can plead as some excuse for my mistake that
postal officials appear to have differed in opinion am
themselves on the matter.

Should this letter meet the eye of any memb
whose replies were returned to them by the Post Of
and who have not yet sent them on again to me, I
that they will kindly do so.

F. H. Webb,
Secretary, I.E.

Paris, *September* 3*rd*, 1889.

[We are pleased to have Mr. Webb's letter, w
sufficiently explains his unfortunate mistake.—
ELEC. REV.]